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A Continuing
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with Indexes

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Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering

ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges.

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NASA SP-7037(201)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 201)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in May 1986 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 438 reports, journal articles, and other documents originally announced in May 1986 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes -- subject, personal author, corporate source, foreign technology, contract number, report number, and accession number -- are included.

An annual cumulative index will be published.

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TYPICAL CITATION AND ABSTRACT FROM *STAR*

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AVAILABILITY SOURCE
REPORT NUMBER
COSATI CODE

N86-10033*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Chemistry.
A FUNDAMENTAL STUDY OF THE STICKING OF INSECT RESIDUES TO AIRCRAFT WINGS Annual Technical Report
N. S. EISS, JR., J. P. WIGHTMAN, D. R. GILLIAM, and E. J. SIOCHI Apr. 1985 191 p refs
(Contract NAG1-300)
(NASA-CR-176231; NAS 1.26:176231) Avail: NTIS HC A09/MF A01 CSCL 01C

The aircraft industry has long been concerned with the increase of drag on airplanes due to fouling of the wings by insects. The present research studied the effects of surface energy and surface roughness on the phenomenon of insect sticking. Aluminum plates of different roughnesses were coated with thin films of polymers with varying surface energies. The coated plates were attached to a custom jig and mounted on top of an automobile for insect collection. Contact angle measurements, X-ray photoelectron spectroscopy and specular reflectance infrared spectroscopy were used to characterize the surface before and after the insect impact experiments. Scanning electron microscopy showed the topography of insect residues on the exposed plates. Moments were calculated in order to find a correlation between the parameters studied and the amount of bugs collected on the plates. An effect of surface energy on the sticking of insect residues was demonstrated.
Author

TYPICAL CITATION AND ABSTRACT FROM *IAA*

NASA SPONSORED DOCUMENT
AVAILABLE ON MICROFICHE
AIAA ACCESSION NUMBER
TITLE
AUTHORS
AUTHOR'S AFFILIATION
CONFERENCE
CONFERENCE DATE

A86-11041*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AERODYNAMIC DESIGN CONSIDERATIONS FOR EFFICIENT HIGH-LIFT SUPERSONIC WINGS
D. S. MILLER and R. M. WOOD (NASA, Langley Research Center, Hampton, VA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs
(AIAA PAPER 85-4076)

A previously developed technique for selecting a design space for efficient supersonic wings is reviewed; this design-space concept is expanded to include thickness and camber effects and is evaluated for cambered wings at high-lift conditions. The original design-space formulation was based on experimental upper-surface and lower-surface normal-force characteristics for flat, uncambered delta wings; it is shown that these general characteristics hold for various thickness distributions and for various amounts of leading-edge camber. The original design-space formulation was also based on the assumption that the combination of Mach number and leading-edge sweep which would produce an equal division of flat-wing lift between the upper and lower surface would also be the proper combination to give the best cambered-wing performance. Using drag-due-to-lift factor as a measure of performance, for high-lift conditions cambered-wing performance is shown to significantly increase as conditions approach the design space; this correlation is demonstrated for both subcritical and supercritical flows.
Author

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 201)

JUNE 1986

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AERONAUTICS (GENERAL)

A86-23760
TESTABILITY OF AIRCRAFT [KONTROLOVATELNOST LETOUNU]
J. VOLNY Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1985, p. 227-231. In Czech.

The requirements for aircraft testability that are essential for the efficient maintenance and repair are summarized. In particular, attention is given to the philosophy of aircraft maintenance, maintenance scheduling, and methods, as well as to the relationship between reliability, testability, and the accessibility of aircraft parts and components during maintenance. The discussion also covers criteria for selecting a test method and the special features of aircraft intended for short-haul operation affecting the selection of the test procedure. Finally, the principal requirements for aircraft test equipment are examined. V.L.

A86-25023
FUTURE HELICOPTER DEVELOPMENTS [ZUKUENFTIGE HUBSCHRAUBER-ENTWICKLUNGEN]
P. HAMEL and B. GMELLIN (DFVLR, Institut fuer Flugmechanik, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), Nov. 1985, p. 56-61. In German. refs

In the future, helicopters will have to satisfy very exacting demands with respect to both civil and military applications. The required enhancement of helicopter performance will be feasible on the basis of an increasing integration of new technologies. Related developments will include the employment of digital-electrical and digital-optical data transmission, microcomputer technology, and sensor and display technology. A higher-level objective of research in the area of flight mechanics is related to an evaluation of improvement possibilities regarding the mission-dependent flight characteristics and performance of helicopters which are more and more controlled automatically, taking into account the assurance of flight safety. Attention is given to a control system for automatic operations in the case of selected flight maneuvers, questions regarding the risks involved in the integration of new technologies, the role of wind tunnel simulation in connection with the consideration of new rotor systems, and the role of the pilot in the control of the helicopter. G.R.

A86-25176#
RELIABILITY AND STRUCTURAL INSPECTION PROGRAM FOR TRANSPORT AEROPLANES
G. FUJIWARA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 372, 1985, p. 1-11. In Japanese. refs

The principle and characteristics of the damage detection rating system for the structural inspection of transport aircraft are reviewed. The system consists of damage tolerance rating, environmental deterioration rating, and accidental damage rating systems. The characteristic functions of these systems are analyzed in relation to the reliability of the inspection and the structural safety requirements. The fleet leader and rotational sampling methods for the damage inspection and the selection method of structurally significant items are described. S.H.

A86-25850
AFFORDABLE SAFETY
J. M. RAMSDEN Flight International (ISSN 0015-3710), vol. 129, Jan. 25, 1986, p. 41-43.

Inspection procedures which will improve aircraft maintenance by reducing human error factors are examined. Examples of aircraft accidents which have occurred due to improper maintenance are presented. The utilization of improved accident reporting technique, such as affordable reporting and the confidential incident reporting system, is studied. The development of an independent internal safety audit system which increase communications between pilots and engineers for all airlines is analyzed. I.F.

A86-26072#
ADVANCES IN SIMULATION, CONTROL AND GUIDANCE AND OTHER SYSTEMS FOR MANNED AND UNMANNED AIRCRAFT
H. N. KRISHNAMURTHY (Aeronautical Development Establishment, Bangalore, India) Defence Science Journal (ISSN 0011-748X), vol. 35, April 1985, p. 171-193. refs

Recent advances in the areas of flight simulation and unmanned flight vehicles at the Aeronautical Development Establishment at Bangalore, India, are presented. Particular attention is paid to aspects of flight modeling and validation, simulation hardware, control and guidance, displays, flight management of manned and unmanned aircraft, design of unmanned flight vehicles, and light-weight structures. Consideration is given to the built-in energy-absorption systems designed to protect the peripheral aircraft structures against bird impact damage, and to shield the structures of unmanned vehicles that are likely to suffer from ground impact during the recovery phase. Block diagrams are included. I.S.

A86-26114
THE WORLD AIRCRAFT INDUSTRY
D. TODD (Manitoba, University, Winnipeg, Canada) and J. SIMPSON London/Dover, MA, Croom Helm/Auburn House Publishing Co., 1986, 282 p. refs

A comprehensive survey of the current state of the world aircraft industry is presented. The development of the industry and its current problems are considered. The role of governments is examined, showing how this differs from country to country. The prospects for the future shape of the industry, as newly industrialized countries become involved, are assessed. C.D.

A86-26274
PLASTIC MEDIA BLAST BEST FOR STRIPPING
J. B. BULLINGTON (U.S. Army, Production Engineering Div., Corpus Christi, TX) ManTech Journal, vol. 10, no. 4, 1985, p. 48-55.

A new cost-effect technique for paint stripping, which complies with nonpollution and safety standards is examined. The plastic media blast (PMB) process of removing acrylic and lacquer topcoats from epoxy prime surfaces, which is applicable to airframes, tail rotors, and composites, is analyzed; the advantages of the PMB technique are discussed. The need to prevent media and dust contamination of specific aircraft components is investigated. The

design of the standard cabinet-type continuous-flow dry air blasting machine used in the PMB process is described. I.F.

N86-18284# Joint Publications Research Service, Arlington, Va.
USSR REPORT: TRANSPORTATION
4 Dec. 1985 67 p Transl. into ENGLISH from various Russian articles
(JPRS-UTR-85-014) Avail: NTIS HC A04

USSR Reports - Transportation (JPRS-UTR-85-014), 4 Dec. 1985, contains reports on Civil Aviation, Motor Vehicles and Highways, Rail Systems, and Maritime and River Fleets. Of particular interest in this issue are articles on air traffic control radar problems, and the use of laser technology to resurface worn aircraft parts.

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A86-22730#
INVESTIGATION OF A TIP CLEARANCE CASCADE IN A WATER ANALOGY RING
J. A. H. GRAHAM (Pratt and Whitney Canada, Longueuil) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 108, Jan. 1986, p. 38-46. refs
(ASME PAPER 85-IGT-65)

The tip clearance flow region of high-pressure axial turbine blades for small gas turbine engines has been investigated in a water flow cascade. The blade model features variable clearance ad variable endwall speeds. The cascade is scaled for Reynolds number and sized to give velocities suitable for visualization. Pressure profiles were measured on one blade, and correlated with the visualization. Unloading is found to be a major feature of the pressure field at both tip and midspan, and is intimately connected with scraping effects and the behavior of the clearance vortex. Some initial hot-film velocity measurements are also presented. Author

A86-22732*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AERODYNAMIC DETUNING ANALYSIS OF AN UNSTALLED SUPERSONIC TURBOFAN CASCADE
D. HOYNIAK (NASA, Lewis Research, Center, Cleveland, OH) and S. FLEETER (Purdue University, West Lafayette, IN) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 108, Jan. 1986, p. 60-67. Previously announced in STAR as N85-26670. refs
(ASME PAPER 85-GT-192)

An approach to passive flutter control is aerodynamic detuning, defined as designed pasage-to-passage differences in the unsteady aerodynamic flow field of a rotor blade row. Thus, aerodynamic detuning directly affects the fundamental driving mechanism for flutter. A model to demonstrate the enhanced supersonic aeroelastic stability associated with aerodynamic detuning is developed. The stability of an aerodynamicaly detuned cascade operating in a supersonic inlet flow field with a subsonic leading edge locus analyzed, with the aerodynamic detuning accomplished by means of nonuniform circumferential spacing of adjacent rotor blades. The unsteady aerodynamic forces and moments on the blading are defined in terms of influence coefficients in a manner that permits the stability of both a conventional uniformally spaced rotor configuration as well as the detuned nonuniform circumferentialy spaced rotor to be determined. With Verdon's uniformly spaced Cascade B as a baseline, this analysis is then utilized to demonstrate the potential enhanced aeroelastic stability associated with this particular type of aerodynamic detuning. Author

A86-23126*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
THE RESPONSE OF AIRFOILS TO PERIODIC DISTURBANCES - THE UNSTEADY KUTTA CONDITION
D. R. POLING and D. P. TELIONIS (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 24, Feb. 1986, p. 193-199. NASA-supported research. refs
(AIAA PAPER 84-0050)

Two cases of unsteady flowfields over a NACA 0012 airfoil at an angle of attack are examined. The first is the classical pitching motion about the airfoil's quarter chord. The second is the flow over a fixed airfoil immersed in the wake of the pitching airfoil. Large reduced frequencies are examined. Measurements were obtained in a water tunnel by laser Doppler velocimetry. Ensemble-averaged velocity measurements were obtained in the vicinity of the trailing edges of both the pitching and the fixed airfoil. The results indicate that the classical unsteady Kutta condition is clearly not valid. An extension of this condition earlier proposed by Giesing and Maskell is examined and some evidence is provided for its support. Author

A86-23133#
NUMERICAL SIMULATION OF LEADING-EDGE VORTEX FLOWS
D. P. RIZZETTA and J. S. SHANG (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452), vol. 24, Feb. 1986, p. 237-245. Previously cited in issue 17, p. 2424, Accession no. A84-37962. refs

A86-23184*# Illinois Univ., Urbana.
A CLASS OF AIRFOILS HAVING FINITE TRAILING-EDGE PRESSURE GRADIENTS
A. I ORMSBEE (Illinois, University, Urbana) and M. D. DAUGHMER (Pennsylvania State University, University Park) Journal of Aircraft (ISSN 0021-8669), vol. 23, Feb. 1986, p. 97-103. Previously cited in issue 07, p. 840, Accession no. A85-19590. refs
(Contract NAG1-76)

A86-23193#
COMPRESSIBILITY CORRECTIONS FOR MULTIFOIL SECTIONS
A. HARRIS (De Havilland Aircraft of Canada, Ltd., Toronto, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 23, Feb. 1986, p. 156-158. Research supported by the Department of National Defence of Canada. refs

The Lieblein and Stockman (1972) method for obtaining the compressible flow within a duct, as modified by Dietrich et al (1983) to yield a compressible flow correction for external flow, is presently applied to the case of a 24 percent-thick augmentor wing multifoil section in cruise configuration. The agreement between theory and experiment thus obtained is especially good in the case of the main airfoil section, confirming the applicability of the external compressibility correction to very thick sections. O.C.

A86-23660
AERODYNAMIC DESIGN OF AN AIRFOIL WITH ALLOWANCE FOR THE CONDITION OF NONSEPARATED FLOW [AERODINAMICHESKOE PROEKTIROVANIE PROFILIA S UCHETOM USLOVIIA BEZOTRYVNOSTI]
Z. KH. NUGMANOV, V. A. OVCHINNIKOV, and V. G. PAVLOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 3, 1985, p. 47-50. In Russian. refs

The paper is concerned with the problem of plotting the contour of an airfoil for a given surface pressure distribution using the theory of potential flow of an incompressible fluid. The airfoil coordinates are determined in the form of a series expansion in Jacobi polynomials whose coefficients are obtained from the flow line equation by the method of successive approximations. The law of pressure recovery beyond the maximum velocity point is expressed in the form of the Stratford analytical function, which ensures nonseparated flow in this region. Results of calculations are presented. V.L.

A86-23770

NEW ASPECTS OF THE SMALL-PERTURBATION METHOD IN AERODYNAMICS [NOVE ASPEKTY METODY MALYCH PORUCH V AERODYNAMICE]

Z. SKODA Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1985, p. 325-328. In Czech. refs

Results obtained with a system for computing the aerodynamic derivatives of an entire aircraft by the method of discrete forces are summarized. The application of this method to nonstationary cases makes it possible to calculate generalized aerodynamic forces for the dynamic analysis of a flexible aircraft. The method of discrete forces is described with respect to the way in which it differs from the method of discrete vortices. B.J.

A86-23775

PRACTICAL DIFFICULTIES IN THE THEORETICAL DESIGN OF LOW-SPEED PROFILES [PRAKTICKE OBTIZE PRI TEORETICKEM NAVRHU NIZKORYCHLOSTNICH PROFILU]

P. BERAK Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1985, p. 355-358. In Czech. refs

It is noted that results of programs for the design of low-speed profiles may be distorted by discretization deviations or by methodological simplifications. In an effort to overcome these difficulties, experience obtained with five programs is analyzed. It is concluded that high-quality profiles can be designed quickly when velocity distributions from proven profiles are applied. B.J.

A86-23776

MEANS TO INCREASE THE LIFT ON AIRCRAFT WING PROFILES [PROSTREDKY KE ZVYSENI VZTLAKU NA PROFILECH KRIDEL LETADEL]

J. MATULA Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1985, p. 359-362. In Czech.

Techniques for increasing the center-line camber and the chord length near the leading and trailing edges are discussed as means to increase the lift on wing profiles. Attention is given to the effect of slat slots near the leading edge as well as to the effect of wing flaps near the trailing edge. B.J.

A86-23777

DEVELOPMENT OF NUMERICAL METHODS OF EXTERNAL HIGH-SPEED AERODYNAMICS [VYVOJ NUMERICKYCH METOD VNEJSI AERODYNAMIKY VYSOKYCH RYCHLOSTI]

M. KLADRUBSKY and K. KOZEL Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1985, p. 363-370. In Czech. refs

Numerical methods involving the study of transonic flow past profiles or wings are reviewed for the period 1971 to the present. Particular attention is given to the development of such methods in Czechoslovakia. B.J.

A86-23778

DISTRIBUTION OF OPTIMAL CIRCULATION ON A PROPELLER BLADE WITH A NONLINEAR DEPENDENCE ON THE NUMBER OF BLADES AND WITH ALLOWANCE TAPERING [ROZLOZENI OPTIMALNI CIRKULACE NA VRTULOVEM LISTU S NELINEARNI VAZBOU NA POCET LISTU A SE ZAHRNUTIM ZUZENI]

S. SLAVIK Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1985, p. 371-375. In Czech. refs

The aerodynamic design of a propeller is discussed from the viewpoint of maximum efficiency under the given conditions. A design principle based on the optimal circulation range is analyzed, and attention is given to the derivation of an explicit relation for the optimal circulation with allowance for tapering and the nonlinear dependence on the number of blades. B.J.

A86-23780

PRESSURE FLUCTUATIONS ON THE EXTERNAL SURFACE OF AN AIRCRAFT [FLUKTUACE TLAKU NA VNEJSIM POVRCHU LETADEL]

J. SULC Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1985, p. 383-387. In Czech. refs

An intense pressure fluctuation field, variable in time and space, forms on the external surface of an aircraft in flight. The basic theoretical aspects of the generation of this field are discussed. An experimental method for investigating this phenomenon is then described; experimental results are presented; and applications to aircraft design are considered. B.J.

A86-23830#

THE DEVELOPMENT OF A SECOND-GENERATION OF CONTROLLED DIFFUSION AIRFOILS FOR MULTISTAGE COMPRESSORS

R. F. BEHLKE (United Technologies Corp., Pratt and Whitney Div., East Hartford, CT) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 11 p. refs

(ASME PAPER 85-IGT-9)

The evolution of Controlled Diffusion Airfoils is traced from inception of the theoretical design model to demonstration of significant performance gains at engine operating conditions in a multistage compressor rig. The proven aerodynamic benefits and versatility of first-generation Controlled Diffusion Airfoil blade elements are extended to the endwall flow region using an Integrated Core/Endwall Vortex design model to produce a new full span optimized second-generation Controlled Diffusion design. Highlighted are the essential roles of extensive cascade, low speed, large scale and high Mach number compressor rig testing in developing and substantiating the second generation Controlled Diffusion technology resulting in a 1.5 percent increase in efficiency and 30 percent increase in surge-free operation relative to first-generation Controlled Diffusion Airfoils. Author

A86-23834#

AERODYNAMIC RESEARCH ON STRAIGHT WALL ANNULAR DIFFUSER FOR TURBOFAN AUGMENTOR

Q. M. XIE and J. G. GU (China Gas Turbine Establishment, Jiangyou, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 7 p. refs

(ASME PAPER 85-IGT-16)

The effect of nonuniform inlet velocity and temperature profile on the aerodynamic performance of a straight wall annular diffuser for a turbofan augmentor has been investigated. The distribution of static pressure, stagnation pressure and temperature has been measured, thus pressure recovery coefficient, velocity profile and temperature profile at different axial station along the diffuser center line can be determined. The experimental results showed that the momentum ratio of two streams across the diffuser inlet flow splitter is the nondimensional flow parameter controlling diffuser aerodynamic performance. Thus, it is possible to simulate turbofan augmentor annular diffuser performance by using a low temperature air flow aerodynamic test under the condition that the diffusers are of similar geometry, have the same inlet velocity profile, and maintain the momentum ratio constant. A correlation for the velocity distribution in the diffuser was also obtained. Author

A86-23948
AERODYNAMICS OF SWEPT WINGS WITH MEDIUM AND SMALL ASPECT RATIOS. II [AERODINAMIKA STRELOVIDNYKH KRYL'EV SREDNIKH I MALYKH UDLINENII. II]
V. V. STRUMINSKII Moscow, AN SSSR, Sektor Mekhaniki Neodnorodnykh Sred, 1983, 63 p. In Russian.
Test results for sweptback (35, 45, and 60 deg) and sweptforward (-30 deg) wings with various aspect ratios are reported, and the characteristic features of flow past these wings are examined. In particular, an analysis is made of the effect of the sweep angle on the aerodynamic characteristics of aircraft over the full range of angles of attack. Solutions are obtained which make it possible to take advantage of the effect of slip in the wing cross-sections and improve the performance characteristics of swept wings. V.L.

A86-24470
HEAT TRANSFER PROBLEMS IN AERO-ENGINES
D. K. HENNECKE (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) IN: Heat and mass transfer in rotating machinery . Washington, DC, Hemisphere Publishing Corp., 1984, p. 353-379. refs
A survey of the heat transfer problems to be solved when developing an aircraft gas turbine engine is presented looking at each engine component separately. It is shown that the responsibilities of the heat transfer engineer have greatly increased. In addition to the design of the cooling system of the 'hot parts', such as the combustor and turbine, these include the evaluation and assessment of the thermal behavior of nearly all other parts such as the fan, compressor, labyrinth seals, bearings, etc. This is the result of the trend in aero-engines toward higher cycle pressures and temperatures, increased reliability with reduced engine weight, and ever tighter clearances to improve performance and, thus, achieve a further reduction in fuel consumption. It is shown that many heat transfer phenomena in aero-engines are not yet understood well enough. Therefore, heat transfer areas that need continued or intensified research are highlighted, demonstrating that many challenging problems remain to be tackled. Author

A86-24471
FUNDAMENTAL HEAT TRANSFER RESEARCH FOR GAS TURBINE ENGINES NASA WORKSHOP OVERVIEW
D. E. METZGER (Arizona State University, Tempe) IN: Heat and mass transfer in rotating machinery . Washington, DC, Hemisphere Publishing Corp., 1984, p. 381-396.
A review and discussion are presented of the objectives, organization, and results of a workshop sponsored by the Aerothermodynamics and Fuels Division, NASA Lewis Research Center, Cleveland, Ohio. The objective of the meeting was to assemble heat transfer specialists from USA industries, universities and government agencies to discuss approaches and priorities for the Center's future plans for research into gas turbine heat transfer fundamentals. Extensive input was solicited from and distributed to participants prior to the meeting. Those inputs, together with the subsequent meeting reports and recommendations, are reproduced and discussed in the present paper. Author

A86-24522
POST STALL STUDIES OF UNTWISTED VARYING ASPECT RATIO BLADES WITH NACA 44XX SERIES. II - AIRFOIL SECTIONS
C. OSTOWARI (Texas A & M University, College Station) and D. NAIK Wind Engineering (ISSN 0309-524X), vol. 9, no. 3, 1985, p. 149-164. refs
The present study is concerned with the poststall aerodynamic characteristics, lift, drag, and pitching moment, of untwisted constant chord blades as a function of airfoil thickness, aspect ratio, and Reynolds number. It is pointed out that these data are helpful for the design of cost-effective wind energy conversion devices. The conducted investigation of three-dimensional, cambered blades made use of the NACA 44XX series of airfoil sections. The presented results have been carefully selected with the objective to give the reader a fair representation of the aerodynamic ramifications of operating in deep stall conditions. G.R.

A86-24627#
STUDIES OF THE AERODYNAMICS OF FLAPS AND SPOILERS IN UNSTEADY FLOW [ETUDES AERODYNAMIQUES DES VOLETS ET SPOILERS EN INSTATIONNAIRE]
M. COSTES and M. RAHAINGOMANANA (ONERA, Chatillon-sous-Bagneux, France) ONERA, TP, no. 1985-149, 1985, 24 p. In French. refs
(ONERA, TP NO. 1985-149)
The experimental and theoretical research on control surfaces and control laws carried out by ONERA over the last decade are summarized. A prime goal of the program is to develop control laws with short response times for conditions such as unstable flight. Models for sinusoidal motions, the accompanying pressure response and the coefficient of pressure are presented, with quasi-steady values being derived from unsteady values that have a frequency which approaches zero. Trials at the Modane wind tunnel have included spoilers placed at various locations of the chord line and studied in two- and three-dimensional flows. Variations were introduced into the flow Mach number, the Re and the steady and unsteady flow parameters in developing the control laws. Steady-unsteady interactions with a trailing edge flap were found to have significant effects. The placement of a spoiler affected the appearance and magnitude of unsteady flow on a wing, causing oscillations which exceeded those of flaps on the trailing edge. Motions of either of the two types of the control surfaces produced unsteady flow and affected the efficiency of the wing used, a RA16SC1 profile. M.S.K.

A86-24630#
A VISCOUS-INVISCID INTERACTION MODEL FOR TRANSONIC UNSTEADY FLOW [METHODE D'INTERACTION VISQUEUX-NONVISQUEUX POUR LE CALCUL DE DECOLLEMENT INSTATIONNAIRE TRANSSONIQUE]
J. L. LE BALLEUR and P. GIRODROUX-LAVIGNE ONERA, TP, no. 1985-152, 1985, 35 p. In French. refs
(ONERA, TP NO. 1985-152)
A numerical method is presented for describing flows with viscous-inviscid interactions with or without separation and illustrated by examples. The model includes a two-equation model for turbulence solved by implicitly with a space-marching technique in both direct and inverse modes. A semi-implicit coupling method which features relaxation of the unsteady effects at the viscous boundary is made to converge at each time step and recapture the downstream viscous effects. The grid used is adaptable to the scale of the phenomena being studied and is also useful for modeling problems involving separation and shock-boundary layer interactions. Results are presented for sample calculations for steady and unsteady separated flows around NLR7301 and NACA64A010 airfoils. The influence of frequency is discussed, along with the effects of shock-induced separation. The model is capable of predicting the magnitude of buffeting which can be expected in transonic flows. M.S.K.

A86-24634#
SOLUTION OF THE NAVIER-STOKES EQUATIONS IN A COMPRESSIBLE FLUID BY AN IMPLICIT METHOD [RESOLUTION DES EQUATIONS DE NAVIER-STOKES EN FLUIDE COMPRESSIBLE PAR UNE METHODE IMPLICITE]
H. HOLLANDERS (ONERA, Chatillon-sous-Bagneux, France) and W. RAVALASON (Aerospatiale, Division Engins Tactiques, Paris, France) ONERA, TP, no. 1985-148, 1985, 43 p. In French. refs
(ONERA, TP NO. 1985-148)
An implicit finite-volume method which is second-order accurate, highly stable, and dissipative in weakly viscous regions, is presented for solving the time-dependent Navier-Stokes equations in integral form, and is applied to steady subsonic and transonic flow calculations over a NACA0012 airfoil in the laminar case, and

over an ogive-cylinder projectile in the turbulent axisymmetric case. For turbulent flows, the mass-averaged Navier-Stokes equations are solved using a mixing-length eddy viscosity model. The results presented emphasize the good properties of stability and fast convergence of the method. Author

A86-24642#
RECENT ADVANCES IN HELICOPTER AERODYNAMICS
J. J. PHILIPPE (ONERA, Chatillon-sous-Bagneux, France), P. ROESCH, A. M. DEQUIN, and A. CLER (Aerospatiale, Paris, France) ONERA, TP, no. 1985-166, 1985, 36 p. refs
(ONERA, TP NO. 1985-166)

The aerodynamics of isolated helicopter rotors and fuselages is addressed, and a few topics in interactional aerodynamics are also considered. Computational approaches to main rotor aerodynamics are examined, including simple blade element theory, prescribed wake models, distorted wake models, free wake models, and problems related to dynamic stall on the retreating blade, unsteady transonic flow on the advancing blade, blade deformations, and the rotor in hover flight. Experimental methods in wind tunnels to measure local and global performance as well as blade pressure are considered. Aspects of rotor design, including airfoil selection, blade twist, and blade planform are discussed. Experimental methods in fuselage aerodynamics are addressed considering problems in wind tunnel testing and examining fuselage drag and interactions in detail. The principal theoretical methods in fuselage aerodynamics are examined, including potential calculations, separated flow models, streamline boundary layer calculations, and wake calculations. C.D.

A86-24703
STATOR ROW UNSTEADY AERODYNAMICS DUE TO WAKE EXCITATIONS
S. FLEETER and V. CAPECE (Purdue University, West Lafayette, IN) IN: Unsteady aerodynamics of turbomachines and propellers; Proceedings of the Symposium, Cambridge, England, September 24-27, 1984 . Cambridge, Cambridge University, 1984, p. 427-446. USAF-supported research. refs

The fundamental unsteady aerodynamics on a vane row of an axial flow research compressor stage are experimentally investigated, demonstrating the effects of airfoil camber and steady loading. In particular, the rotor wake generated unsteady surface pressure distributions on the first stage vane row are quantified over a range of operating conditions. These cambered airfoil unsteady data are correlated with predictions from a flat plate cascade inviscid flow model which considers both nonseparated and suction surface flow separation. At the design point, the unsteady pressure difference coefficient data exhibit excellent correlation with the nonseparated predictions, with the aerodynamic phase lag data exhibiting good trendwise correlation. The quantitative phase lag differences are associated with the camber of the airfoil. An aft suction surface flow separation region is indicated by the steady state surface static pressure data as the aerodynamic loading is increased. This separation affects the increased incidence angle unsteady pressure data, with these data correlating with the aft suction surface separated flow predictions. Author

A86-24708
COMPARATIVE MEASUREMENTS OF THE UNSTEADY PRESSURES AND THE TIP-VORTEX PARAMETERS ON FOUR OSCILLATING WING TIP MODELS
W. J. WAGNER (DFVLR, Institut fuer Aeroelastik, Goettingen, West Germany) IN: Unsteady aerodynamics of turbomachines and propellers; Proceedings of the Symposium, Cambridge, England, September 24-27, 1984 . Cambridge, Cambridge University, 1984, p. 513-531. refs

Experimental investigations on steady and unsteady pressure distributions and on the tip vortex qualities of four wing tip configurations (rectangular tip, ogee tip, trapezoidal tip, swept tip) are presented and discussed. The analyses of the results show some unexpected phenomena such as double vortex structures and changing vortex structures during blade oscillation. The tip vortex qualities were investigated by means of an ultrasonic measuring device. The results give insight into the finer structure of the vortices and supply information on vortex position, core diameter and maximum velocity as well as vortex behavior if the blade is oscillated. All four configurations show a concave curvature of the lines of equal pressure on the region where the tip vortex originates. This is a sign of underpressure fields induced there. Author

A86-24729*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AERODYNAMIC PERFORMANCE OF TWO FIFTEEN-PERCENT-SCALE WIND-TUNNEL DRIVE FAN DESIGNS
D. B. SIGNOR (NASA, Ames Research Center, Moffett Field, CA) and H. V. BORST (Borst and Associates, Wayne, PA) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 21-35. refs
(AIAA PAPER 86-0734)

An experimental and analytical investigation of two fan blade designs was conducted. The fan blades tested were 15 percent scale models of the blades used in the National Full Scale Aerodynamic Complex fan drive at NASA Ames Research Center. The fan blades were composed of NACA-65 and modified NACA-65-series airfoil design sections. The blades with modified 65-series sections incorporated increased thickness on the upper surface, between the leading edge and the one-half chord position. Twist and taper were the same for both blade designs. The fan blades with modified 65-series sections were found to have an increase in stall margin when they were compared with the unmodified blades. The experimental performance data agreed favorably with theoretical calculations. Author

A86-24732#
AN ESTIMATION OF THE WALL INTERFERENCE ON A TWO-DIMENSIONAL CIRCULATION CONTROL AIRFOIL
N. J. WOOD (Stanford University, CA) and E. O. ROGERS (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 57-63. refs
(AIAA PAPER 86-0738)

Tests in two different wind tunnels of the same series of circulation control airfoils has provided insight into the nature of tunnel wall interference on the data obtained from high lift airfoils. In particular, strong influence of the chord-to-height ratio is shown - in this case a 12 percent difference in the apparent (uncorrected) sensitivity of lift to jet momentum level. These performance changes are found to arise from differences in effective incidence and a correlation with existing interference theory is established. Substantiation of a simple technique (inviscid pressure distribution matching) for identifying the effective angle of attack directly from airfoil data is obtained by demonstrating a collapse of data from the two wind tunnels. As an important contribution to the aerodynamics of circulation control airfoils, the correction of the angle of attack to free air conditions has indicated that the mid-chord pitching moment is essentially decoupled from the blowing momentum. Author

A86-24760#
AN EXPERIMENTAL STUDY OF A HIGH PERFORMANCE CANARD AIRFOIL WITH BOUNDARY LAYER TRIP AND VORTEX GENERATORS
M. G. BRAGG and G. M. GREGOREK (Ohio State University, Columbus) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 361-368.
(AIAA PAPER 86-0781)

The canard airfoil from the Voyager aircraft was tested in The Ohio State University's Subsonic Wind Tunnel. This highly optimized

laminar flow section has good clean airfoil performance but suffers severe lift and drag penalties with early boundary layer transition. These performance penalties result from a midchord boundary layer separation. An experimental program was conducted to document this problem and then to design and test vortex generators to improve the tripped airfoil performance while having the least affect on the clean airfoil. A set of properly designed vortex generators are shown along with the aerodynamic results to document their performance. A brief study of the effect of surface roughness in the turbulent boundary layer is also discussed. Author

A86-25005#
NAVIER-STOKES SOLUTIONS USING FINITE VOLUME PROCEDURES [NAVIER-STOKES LOESUNGEN MIT FINITEN VOLUMEN VERFAHREN]
D. SCHWAMBORN and E. KATZER (DFVLR, Institut fuer theoretische Stroemungsmechanik, Goettingen, West Germany) IN: Numerical aerodynamics - Current status in Germany; Symposium, Neubiberg, West Germany, July 2, 3, 1984, Reports . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1984, p. 54-60. In German. refs

A project whose goal is to develop a modular computer program system for solving the Navier-Stokes and Euler equations for various flow configurations is discussed. The types of configurations involved are described and subsidiary goals involved in the project are mentioned, including the study of the influence of the grid and of artificial dissipation. The present status of the project is summarized. C.D.

A86-25006#
NAVIER-STOKES PROCEDURE FOR SIMULATING TWO-DIMENSIONAL AND QUASI-TWO-DIMENSIONAL CASCADE FLOW [EIN NAVIER-STOKES VERFAHREN ZUR SIMULATION ZWEIDIMENSIONALER UND QUASI-ZWEIDIMENSIONALER GITTERSTROEMUNGEN]
O. SCHAEFER (Stuttgart, Universitaet, West Germany) IN: Numerical aerodynamics - Current status in Germany; Symposium, Neubiberg, West Germany, July 2, 3, 1984, Reports . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1984, p. 61-71. In German.

Improvements in the mathematical modelling, solution algorithm, grid, and boundary conditions pertaining to the numerical simulation of real flows through straight blade cascades are presented. These improvements make the calculative procedure more exact and efficient. Results using these improvements are presented for the NACA 8410 turbine cascade, separated laminar cascade flows, and subsonic flow through the 9C7 compressor cascade with strong sidewall contraction. Good agreement is obtained with comparable solutions and with measurements. C.D.

A86-25022
THE LAMINAR WING - A WAY FOR IMPROVING THE ECONOMY OF COMMERCIAL AIRCRAFT [DER LAMINARFLUEGEL - EIN WEG ZUR VERBESSERUNG DER WIRTSCHAFTLICHKEIT VON VERKEHRSFLUGZEUGEN]
K.-H. HORSTMANN, H. KOESTER, G. REDEKER, and A. QUAST (DFVLR, Institut fuer Entwurfs-Aerodynamik, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), Nov. 1985, p. 51-55. In German.

In the context of efforts to improve the economy of aircraft operations, new commercial aircraft with considerably reduced fuel consumption are being developed. Aerodynamics makes an important contribution to these efforts by providing new technologies which are capable to reduce drag. The national research program the 'Laminar Wing' is to establish the foundations for the use of a laminar wing with low drag characteristics in larger aircraft. The DFVLR is the initiator and an important partner in this program. It is pointed out that low-drag laminar wings are already employed in gliders for several decades. The technology of the laminar wing is discussed along with basic information regarding the determination of the laminar-turbulent transition, the design of laminar profiles for commercial aircraft, the economics of an operation of commercial aircraft with laminar wings, and problems arising in the case of a commercial aircraft with laminar wings. It is concluded that savings in fuel of approximately 30 percent in comparison to conventional aircraft are possible. G.R.

A86-25084* Massachusetts Inst. of Tech., Cambridge.
ENERGETICS AND OPTIMUM MOTION OF OSCILLATING LIFTING SURFACES OF FINITE SPAN
A. R. AHMADI and S. E. WIDNALL (MIT, Cambridge, MA) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 162, Jan. 1986, p. 261-282. Research supported by Bolt Beranek and Newman, Inc. refs
(Contract NGR-22-009-818)

In certain modes of animal propulsion in nature, such as bird flight and fish swimming, the efficiency compared to man-made vehicles is very high. In such cases, wing and tail motions are typically associated with relatively high Reynolds numbers, where viscous effects are confined to a thin boundary layer at the surface and a thin trailing wake. The propulsive forces, which are generated primarily by the inertial forces, can be calculated from potential-flow theory using linearized unsteady-wing theory (for small-amplitude oscillations). In the present study, a recently developed linearized, low-frequency, unsteady lifting-line theory is employed to calculate the (sectional and total) energetic quantities and optimum motion of an oscillating wing of finite span. G.R.

A86-25189#
DOUBLET STRIP METHOD FOR OSCILLATING RECTANGULAR WINGS IN SUBSONIC FLOW
A. ICHIKAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 374, 1985, p. 152-159. In Japanese, with abstract in English. refs

An improved numerical method is presented for calculating the load distribution on oscillating rectangular wings in subsonic flow. The wing is divided into many chordwise strips. In the strips containing the control point, the kernel function is treated in the form of an expansion series, and spanwise integration is performed to obtain a chordwise logarithmic singularity. Through accurate evaluation of the singularity, the present method gives quick convergence and excellent computational efficiency to other current methods. Author

A86-25200#
IMPROVED DOUBLET LATTICE METHOD FOR OSCILLATING SWEPT TAPERED WINGS IN INCOMPRESSIBLE FLOW
A. ICHIKAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 376, 1985, p. 296-303. In Japanese, with abstract in English. refs

An improved doublet lattice method is presented for calculating the load distributions on oscillating swept tapered wings in incompressible flow. The integration domain is transformed into a rectangular one, and the wing is divided into many chordwise strips. In the strip containing control points, Cauchy singularity and logarithmic singularity are properly accounted for. The solutions generally compare well with other lifting surface theories, but with much smaller computational times, and the method is found to be more accurate and to converge faster than conventional doublet lattice methods. Author

A86-25206#
RECENT COMPUTATIONAL FLUID DYNAMICS WORKS ABOUT HIGH ANGLE OF ATTACK AERODYNAMICS WITH SEPARATION VORTEX
K. FUJII Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 377, 1985, p. 339-350. In Japanese. refs

Recent developments in the numerical simulation of a separation vortex with a high angle of attack are reviewed. The numerical simulation methods include a time-marching method using the complete Navier-Stokes equations, the thin-layer Navier-Stokes equation, and the Euler equation, and a space-marching method using a parabolic Navier-Stokes equation,

a thin-layer parabolic Navier-Stokes equation, and the Euler equation. S.H.

A86-25207#

REVIEW OF THEORY OF VORTEX SEPARATED FROM A LEADING EDGE OF A DELTA WING

S. KUBO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 377, 1985, p. 350-355. In Japanese. refs

Recent developments in the theory of vortex separation from a leading edge of a delta wing, and its future prospects are described. The concept of vortex lift of the delta wing based on the leading-edge separation analogy, the roll-up vortex layer theory, and the limit of the separation vortex from a leading edge of the delta wing are characterized. S.H.

A86-25224#

AERODYNAMIC PERFORMANCES OF FABRIC SURFACE AIRFOILS

M. KOBAYAKAWA and Y. KONDO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 379, 1985, p. 491-494. In Japanese, with abstract in English. refs

Aerodynamic performances are measured for airfoils and circular cylinders with fabric surface. Generally, the critical Reynolds number for the drag of circular cylinder depends on the surface roughness. The measured results of the cylinders with fabric surface agree with Achenbach's results of sand roughness. The lift to drag ratios of the airfoil (NACA-0012) are much affected by fabric roughness. The differences of the lift to drag ratio between the different roughness are largest near their maximum values and decrease as the angle of attack increases. After the stall, no differences appear. The lift to drag ratio is also affected by the directions of stich. The lift to drag ratio decreases abruptly as k, the parameter of fabric roughness, increases to 0.2, but over this value its tendency becomes milder. Author

A86-25227#

ON HYPERSONIC FLOW AROUND WINGED-VEHICLES AT HIGH ANGLES OF ATTACK

M. YASUHARA, K. TSUBOI, N. FUKUDA, and K. SAKURAI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 380, 1985, p. 516-524. In Japanese, with abstract in English. refs

Experiments on hypersonic flow around a caret wing and a winged vehicle were conducted in a shock tunnel with a conical nozzle, at a Mach number of 8. Three force components and surface pressures were measured for a wide range of attack angle up to 45 deg, and compared with Newtonian flow theory, giving good comparisons for the nearly flat-bottomed models, except pitching moments. The source flow produced by the conical nozzle affects measured pressures and forces, and some corrections are necessary. Author

A86-25233#

A STUDY ON THE PROPULSIVE FORCE OF WINGS IN NON-STEADY MOTION BY THE THEOREM OF MOMENTUM

T. ICHIKAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 381, 1985, p. 575-583. In Japanese, with abstract in English. refs

Propulsive force is considered of a two-dimensional airfoil executing a nonsteady out-of-plane motion from a standpoint of the theorem of momentum in the framework of the linear theory. By regarding the system of the airfoil and wake as a superposition of vortex pairs, it is shown that, for a harmonically oscillating airfoil, an appropriate form of the wake vortex sheet to give the correct propulsion is one that is determined under the influence of the upwash of the airfoil only. Concering the time mean of the propulsion of the oscillating airfoil, this approach is shown to be equivalent to the method for calculating the drag force of a cylindrical body using the Karaman vortex street. Author

A86-25239#

TWO-DIMENSIONAL SCHEME 'DLM-C' TO EXAMINE SUBSONIC UNSTEADY LIFTING SURFACE SCHEMES FOR FINITE SPAN

S. ANDO, M. KATO, and A. ICHIKAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 382, 1985, p. 635-640. In Japanese, with abstract in English. refs

In order to investigate accuracy and convergence characteristics of any unsteady lifting surface computation programs, it is found that the 'DLM-C' scheme for two-dimensional airfoils is quite useful. This scheme is reliable up to high reduced frequencies k and high subsonic free stream Mach numbers M. It has comparable efficiency with NASA 2-D, within published k and M values. For a rectangular wing of aspect ratio ten, chordwise lift distributions on the midspan section are computed by using some unsteady lifting surface programs, which are compared with DLM-C. The values of error-index parameters E are entered in a k vs M diagram, and constant E curves are drawn. This diagram shows clearly the upper limit of k where the scheme is efficient. Author

A86-25240#

AERODYNAMIC CHARACTERISTICS OF SLENDER WING-GAP-BODY COMBINATIONS. II

Y. YAMAMOTO and S. ANDO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 382, 1985, p. 641-648. In Japanese, with abstract in English. refs

Aerodynamic characteristics of slender wing-gap-body combinations are studied exactly in the framework of slender-body theory. In a previous paper, the solutions of total lift curve slope were obtained, in which the wings and the body have different incidence with respect to the free stream, and arbitrary width of chordwise gaps exist between the wings and body. In this work, the induced drag as well as the lift is evaluated exactly. This requires that the lift due to the wings and the lift due to the body are separately known. Many problems in which missile aerodynamicists have interest may be covered. Author

A86-25599

AERODYNAMICS OF LIFTING SURFACES IN STEADY FLOW [AERODINAMIKA NESUSHCHIKH POVERKHNOSTEI V USTANOVIVSHEMSIA POTOKE]

N. F. VOROBEV Novosibirsk, Izdatel'stvo Nauka, 1985, 240 p. In Russian. refs

Problems concerning subsonic and supersonic flow past surfaces are reduced to solving integral equations, and examples of exact solutions are presented. Green functions are determined for the wave equation for prismatic regions, which makes it possible to obtain solutions to problems of supersonic flow past complex configurations with allowance for reflection and diffraction phenomena. Approximations of solutions to integral equations are discussed; the convergence behavior of the discrete vortex method is analyzed. V.L.

A86-25670

TEST CASES FOR THE PLANE POTENTIAL FLOW PAST MULTI-ELEMENT AEROFOILS

A. SUDDHOO and I. M. HALL (Manchester, Victoria University, England) Aeronautical Journal (ISSN 0001-9240), vol. 89, Dec. 1985, p. 403-414.

The method of images is used to calculate the analytical solution for an inviscid incompressible flow past four arbitrary circles which are then conformally mapped onto aerofoil sections. The analytical solution of the corresponding flow past the system of aerofoils is obtained and the pressure distributions about a particular three-element and a particular four-element aerofoil are presented. These results are intended to be used to assess the accuracy of numerical methods. Author

A86-26106*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN EXPERIMENTAL INVESTIGATION OF THE PARALLEL BLADE-VORTEX INTERACTION

F. X. CARADONNA, G. H. LAUB, and C. TUNG (NASA, Ames Research Center; U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 29 p. Previously announced in STAR as N85-13777. refs

A scheme for investigating the parallel blade vortex interaction (BVI) has been designed and tested. The scheme involves setting a vortex generator upstream of a nonlifting rotor so that the vortex interacts with the blade at the forward azimuth. The method has revealed two propagation mechanisms: a type C shock propagation from the leading edge induced by the vortex at high tip speeds, and a rapid but continuous pressure pulse associated with the proximity of the vortex to the leading edge. The latter is thought to be the more important source. The effects of Mach number and vortex proximity are discussed. Author

A86-26107#

SOME CALCULATIONS OF TIP VORTEX - BLADE LOADINGS

N. BALTAS and G. J. HANCOCK (Queen Mary College, London, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 9 p.

Transient tip vortex-blade loadings are calculated from an inviscid steady model in which the tip vortex is idealized as a discrete line vortex while the blade loading is represented by a vortex lattice arrangement. Mach number effects are neglected. Author

A86-26108#

A CONSISTENT MATHEMATICAL MODEL TO SIMULATE STEADY AND UNSTEADY ROTOR-BLADE AERODYNAMICS

U. LEISS (Muenchen, Universitaet der Bundeswehr, Munich, West Germany) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 16 p. refs

A general formulation has been developed to simulate the stalled and unstalled aerodynamic coefficients of a rotor blade in steady and unsteady flow. The main features of the present method are few empirical parameters with physical background in the full range in angle of attack and Mach number without the need to sectionize the validity of parameters. The method takes account for different types of steady stall and the influence of Reynolds number. Unsteady effects due to pitch, plunge and fore and aft motion are separately implemented. The calculated steady normal force coefficient curve and the unsteady hysteresis loops of the present method match very well with the two-dimensional test data, even for high frequencies. In addition some comparisons with other methods are presented. Aerodynamic rotor forces can be obtained by analytical integration of the section forces over the span of the blade and analytical derivatives of these forces are possible. Author

A86-26109#

COMPARATIVE MEASUREMENTS OF THE UNSTEADY PRESSURES AND THE TIP-VORTEX PARAMETERS OF FOUR OSCILLATING WING TIP MODELS

W. J. WAGNER (DFVLR, Institut fuer Aeroelastik, Goettingen, West Germany) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 18 p. refs

Experimental investigations on steady and unsteady pressure distributions and on the tip vortex qualities of four wing tip configurations (rectangular tip, Ogee tip, trapezoidal tip, swept tip) are presented and discussed. The tip vortex qualities were investigated by means of an ultrasonic measuring device. The results give insight into the finer structure of the vortices and supply information on vortex position, core diameter and maximum velocity as well as vortex behavior if the blade is oscillated. This is demonstrated by a selection of a few single conditions. Author

A86-26110#

RADIAL DISTRIBUTION CIRCULATION OF A ROTOR IN HOVER MEASURED BY LASER VELOCIMETER

M. NSI MBA, C. MEYLAN, C. MARESCA, and D. FAVIER (Aix-Marseille II, Universite, Marseille, France) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 15 p. refs

(Contract DRET-82-432)

A laser velocimeter was used to determine the circulation by integration of the velocity vector along a contour surrounding the blade section of a helicopter in hover. Two different contours were tested and compared. The radial distribution of circulation were then measured for rotors of different tip shape (rectangular, parabolic, tapered, swept) and presented comparatively to numerical results based on a free wake analysis code. Author

A86-26112#

THEORETICAL PREDICTION OF RUNNING-TIME MEASUREMENTS IN UNSTEADY FLOW

W. SEND (DFVLR, Institut fuer Aeroelastik, Goettingen, West Germany) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 17 p. refs

The results obtained for the present theoretical predictions of running time measurements, in the context of an investigation of various rotor blade tip clearances, are aimed at a deeper understanding of vorticity formation and concentration in the wake of a blade. The physical assumptions for the flow are infinitely high Reynolds number and incompressible flow, which lead to a simplified vorticity transport equation. Attention is given to the analytical solution of the three-dimensional wake integral in unsteady flow, which permits fast and precise computation of induced velocity fields. Theoretical and experimental results are compared for two different profiles in the cases of reduced frequency, amplitude, and steady angle-of-incidence. O.C.

N86-18287# National Research Council of Canada, Ottawa (Ontario). High Speed Aerodynamics Lab.

SUBSONIC WALL INTERFERENCE CORRECTIONS FOR HALF-MODEL TESTS USING SPARSE WALL PRESSURE DATA

M. MOKRY Nov. 1985 35 p refs Presented at the Euromech Colloquium No. 187 on Adaptive Wall Wind Tunnels and Wall Interference Correction Methods, Goettingen, West Germany, 15-17 Oct. 1984

(LR-616; NRC-25132) Avail: NTIS HC A03/MF A01

A method is described for correcting subsonic wind tunnel measurements on half-models in ventilated test sections, operated at subcritical flow conditions at the walls. For perforated walls, the boundary values of the streamwise component of the wall interference velocity are obtained from static pressures measured by a few longitudinal pressure tubes or rails attached to the walls and from the estimated farfield of the model in free air. The sparse boundary data is extended by means of streamwise smoothing and transverse interpolation. The streamwise velocity correction is derived from the doublet panel solution of an interior Dirichlet problem and the transverse corrections by integrating the irrotational flow conditions. The evaluated corrections to Mach number and angle of attack, presented as contour plots in the wing plane, provide insight into the correctability of the test results. Examples are given for a transport aircraft half-model tested in the NAE high speed wind tunnel. Applicability of the method at supercritical flow conditions at the model is examined on experimental and computational data of a high aspect ratio wing. Author

N86-18289*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMPRESSIBLE, UNSTEADY LIFTING-SURFACE THEORY FOR A HELICOPTER ROTOR IN FORWARD FLIGHT
H. L. RUNYAN and H. TAI Dec. 1985 21 p refs
(NASA-TP-2503; L-15976; NAS 1.60:2503) Avail: NTIS HC A02/MF A01 CSCL 01A

A lifting-surface theory has been developed for a helicopter rotor in forward flight for compressible and incompressible flow. The method utilizes the concept of the linearized acceleration potential and makes use of the doublet lattice procedure. Calculations demonstrating the application of the method are given in terms of the lift distribution on a one-bladed rotor, a two-bladed rotor, and a rotor with swept-forward and swept-back tips. Also, the lift on a rotor vibrating in a pitching mode at 4 per revolution is given. Compressibility effects and interference effects for a two-bladed rotor are discussed. Author

N86-18294# Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.
CALCULATION OF HELICOPTER AIRFOIL CHARACTERISTICS FOR HIGH TIP-SPEED APPLICATIONS
W. J. MCCROSKEY, J. D. BAEDER, and J. O. BRIDGEMAN 17 May 1985 16 p Presented at the 41st Annual Forum for the American Helicopter Society, Fort Worth, Tex., 15-17 May 1985
(AD-A160694) Avail: NTIS HC A02/MF A01 CSCL 20D

In this paper, we have applied a new aerodynamic tool to the study of helicopter airfoil characteristics. We have shown that the computed airloads reproduce completely the experimental behavior of representative airfoils across the transonic regime. In addition, the computational details of the flow fields, the surface pressure distributions, and the viscous-layer characteristics enable us to trace the evolution of the physical changes that occur as m infinity or Re increases. Descriptions of the complicated development of shock waves, shock-induced separation supplement the information that has been obtained heretofore in wind tunnels. In validating our calculations and assessing the accuracy of the results, including extensive grid-refinement studies and comparisons with data from numerous wind tunnels, we have defined more precisely the capabilities and limitations of the code ARC2D. This important aspect of the investigations can complement wind-tunnel tests, by providing flow-field details that are difficult to measure and by extending the range of flow parameters beyond the capabilities of existing wind tunnels. The code has now progressed from a purely research stage to almost a production stage, where it can be run by specialists in the helicopter industry. GRA

N86-18296# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
THE CONFORMAL REPRESENTATION OF THE NACA 642A015 PROFILE [DE CONFORME AFBEELDING VAN HET PROFIEL NACA 642A015]
J. J. H. BLOM Apr. 1984 51 p refs In DUTCH
(VTH-M-502) Avail: NTIS HC A04/MF A01

In order to construct a wind tunnel model of the symmetric NACA 642A015 airfoil profile, a Timman based airfoil transformation method was used. A smoother and tighter contour profile is obtained. The number of profile coordinates (z-plane) is brought up to 100 points, equidistantly situated on the circle contour (zeta-plane). Adjacent coordinates are calculated using Schoenberg interpolation polynomials. Author (ESA)

N86-18301# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
CALCULATION OF THE EXTERNAL NACELLE SURFACE FOR SINGLE AND DOUBLE STREAM JET ENGINES FOR CIVIL AIRCRAFT [DE BEREKENING VAN HET OMSPOELD GONDELOPPERVLAK VAN ENKEL- EN DUBBELSTROOM STRAALMOTOREN VOOR CIVIELE VLIEGTUIGEN]
E. TORENBEEK and G. H. BERENSCHOT Jan. 1983 40 p refs In DUTCH
(VTH-M-445) Avail: NTIS HC A03/MF A01

Simple formulas to be used in the conceptual design phase of civil aircraft for the calculation of principal dimensions and external surface of nacelles for single and double stream engines with turbocompressors are derived and verified. Nacelle surfaces of 35 engines, used in existing or planned aircraft, are determined to verify the formulas. Missing essential dimensions, such as inlet diameter and nacelle length, are referred to performance magnitudes such as bypass ratio and propulsion. Introducing (semi-) static relations, formulas whose applicability depends on available data are derived. An accuracy of 6.5% is reached; the most simple formula has a standard deviation of 12%. Author (ESA)

N86-18303# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
ON THE LONGEST CHORD OF THE FIRST MULLER PROFILE [OVER DE LANGSTE KOORDE VAN HET EERSTE PROFIEL VAN MUELLER]
J. J. H. BLOM Oct. 1983 20 p refs In DUTCH
(VTH-M-486) Avail: NTIS HC A02/MF A01

Using literature data, the coordinates, front point, and longest chord, defined as the largest distance between the sharp profile back edge and a point of the profile contour (= the front point) of the Muller wing profile were determined. A simpler transformation function for profile parameters, such as tail angle, curvature, and thickness, used in a Timman based iterative airfoil transformation program, is provided by Muller. Before profile forms can be compared with each other, a normalization on the longest chord is required. The tangent to the contour in the front point is at right angle to the longest chord. For so-called classical profile families, relations indicating exactly the front point can be derived. Author (ESA)

N86-18304# Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Research and Testing Dept.
PARAMETRIC DETERMINATION OF LIFT INTERFERENCE FOR THREE-DIMENSIONAL MODELS IN THE EMMEN (SWITZERLAND) AIRCRAFT WORKS WIND TUNNEL
G. CAPITAINE 31 Aug. 1984 35 p refs In GERMAN; ENGLISH summary
(F+W-FO-1740) Avail: NTIS HC A03/MF A01

Wind tunnel wall interference effects on the flow around a model were investigated for correction of the test values. A FORTRAN 77 program is developed for determination of the lift interference correction with specific slit parameters and porosity parameters for a three-dimensional compressible flow in a rectangular test section with slotted top and botton walls and closed vertical walls. The numerical procedure is applied to entire configurations and semiconfigurations. The results are plotted on charts to determine the variations of the lift correction and streamline curvature factors for different slit parameters. Author (ESA)

N86-19283 Purdue Univ., West Lafayette, Ind.
AN EXPERIMENTAL INVESTIGATION OF PROPELLER WAKES USING A LASER DOPPLER VELOCIMETER Ph.D. Thesis
R. M. SUNDAR 1985 196 p
Avail: Univ. Microfilms Order No. DA8520081

This report presents a detailed investigation of the performance and flowfield of three single rotation propellers. These propellers were designed to demonstrate the efficiency improvements attainable by using proplets and biblades. Direct measurement of thrust by a parallelogram balance and power by measuring the input to the propulsion unit (dc motor) was used to determine the

efficiency of the propellers. The force measurements demonstrated that the use of proplets did produce an efficiency improvement under high loading conditions in static operation as well as with forward speed. The improvement in static thrust by using proplets was comparable with that of a shrouded propeller. The flow field in the wake of the propellers was investigated with an LDV system. The measured velocity field is compared with the theoretical velocity field. Biot-Savarts' law was applied to the theoretically assumed vortex geometry in the wake to determine the theoretical velocity field. Dissert. Abstr.

N86-19284# Committee on Science and Technology (U. S. House).
HIGH SPEED AERONAUTICS
Washington GPO 1985 195 p Hearing before the Subcommittee on Transportation, Aviation and Materials of the Committee on Science and Technology, 99th Congress, 1st Session, no. 21, 24 Jul. 1985
(GPO-51-341) Avail: Subcommittee on Transportation, Aviation and Materials

Testimonies on the research and development of hypersonic speed aviation is presented. The effect of high speed aircraft on space flight is noted. The need to press forward in this research in order to keep up with other countries is emphasized. Budgetary requirements are also considered. E.R.

N86-19285# National Aeronautical Establishment, Ottawa (Ontario). High Speed Aerodynamics Lab.
ANALYSIS OF EXPERIMENTAL DATA FOR A 21% THICK NATURAL LAMINAR FLOW AIRFOIL, NAE68-060-21:1
D. J. JONES and M. KHALID Oct. 1985 56 p refs
(NAE-AN-34; NRC-25076; AD-A162914) Avail: NTIS HC A04/MF A01

Results obtained from wind tunnel tests on a 21% thick supercritical airfoil capable of sustaining long runs of laminar flow on both surfaces are presented. The measured drag levels are superior to those of any model previously tested in this facility and are comparable to classical NACA and modern NASA NLF airfoils. Author

N86-19286# National Aerospace Lab., Tokyo (Japan).
AERODYNAMIC TRANSFER FUNCTIONS FOR A FINITE WING IN INCOMPRESSIBLE FLOW
H. MATSUSHITA 1985 58 p refs In JAPANESE; ENGLISH summary
(NAL-TR-867; ISSN-0389-4010) Avail: NTIS HC A04/MF A01

The aerodynamic transfer functions for a wing with a control surface in an incompressible flow are presented analytically using Laplace transform technique. The aerodynamic transfer function for an airfoil can be analytically represented with the generalized Theodorsen function as circulatory parts and the rational function as noncirculatory parts. The aerodynamic transfer function for a finite wing is obtained in a closed form which includes the nonrational function called a modified circulation. A modified circulation function shows a finite wing effect and is governed by an integro-differential equation, which can be solved efficiently by numerical computation. These results extend the simple harmonic theory to a general transient motion. With the expression thus obtained, the characteristics of the aerodynamic transfer function for a finite wing clearly show that it should have a branch point at the origin and have no singularities along the negative real axis. Transient aerodynamic forces in time domain such as an indicial lifts are obtained by inverse Laplace transforming the present results. Comparison of these results with the other methods and the experimental values shows a good agreement. Author

N86-19287*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LOW-SPEED WIND-TUNNEL INVESTIGATION OF THE EFFECT OF STRAKES AND NOSE MACHINES ON LATERAL-DIRECTIONAL STABILITY OF A FIGHTER CONFIGURATION
J. M. BRANDON Washington Feb. 1986 33 p refs
(NASA-TM-87641; L-16051; NAS 1.15:87641) Avail: NTIS HC A03/MF A01 CSCL 01A

A series of low-speed static wind-tunnel force tests were conducted on a 0.15-scale model of a modern high-performance fighter aircraft. The tests identified the use of nose chines to enhance stability at high angles of attack. Results of this investigation showed that the strake was the major contributor to directional instability. The destabilizing forces were created by two mechanisms: (1) adverse flow in the region of the vertical tail, and (2) forces generated on the fuselage ahead of the center of gravity. Properly designed nose chines effectively negated the adverse flow near the vertical tail and created stabilizing forces on the forebody in the range of the stall angle of attack. Author

N86-19288*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LOADS AND AEROELASTICITY DIVISION RESEARCH AND TECHNOLOGY ACCOMPLISHMENTS FOR FY 1985 AND PLANS FOR FY 1986
J. E. GARDNER and S. C. DIXON Jan. 1986 125 p
(NASA-TM-87676; NAS 1.15:87676) Avail: NTIS HC A06/MF A01 CSCL 01A

The Langley Research Center Loads and Aeroelasticity Division's research accomplishments for FY85 and research plans for FY86 are presented. The rk under each branch (technical area) will be described in terms of highlights of accomplishments during the past year and highlights of plans for the current year as they relate to five year plans for each technical area. This information will be useful in program coordination with other government organizations and industry in areas of mutual interest. Author

N86-19291# Naval Surface Weapons Center, Silver Spring, Md.
GENERATION OF THE STARTING PLANE FLOWFIELD FOR SUPERSONIC FLOW OVER A SPHERICALLY CAPPED BODY
T. HSIEH and F. J. PRIOLO 9 May 1985 286 p
(AD-A161117; NSWC/TR-84-484) Avail: NTIS HC A13/MF A01 CSCL 20D

This report describes a fast method to provide a three dimensional starting flowfield to be used in a space-marching-type calculation for the afterbody flowfield of spherically capped missiles at incidence in supersonic flight speed. Utilizing the property of spherical symmetry of the flowfield about a sphere, three dimensional starting plane flowfield may be interpolated from the results of an axisymmetric flowfield about a sphere, which is available from an existing computer program (NOSTIP) with considerably less computing time. The analysis of the interpolation method, examples and listings of computer programs for the axisymmetric and the three dimensional starting plane flowfields about a sphere in the Mach number range from 1.5 to 10 and angle of attack between 0 to 35 degrees are presented. Author (GRA)

N86-19292# National Aeronautical Establishment, Ottawa (Ontario).
WIND TUNNEL CALIBRATION OF A PMS (PARTICLE MEASURING SYSTEMS) CANISTER INSTRUMENTED FOR AIRFLOW MEASUREMENT
J. I. MACPHERSON Sep. 1985 64 p
(AD-A161124; NAE-AN-32; NRC-24922) Avail: NTIS HC A04/MF A01 CSCL 20F

Measurements of cloud particle images and concentrations using laser spectrometers housed in pods mounted on the wings or fuselages of research aircraft can be affected by the distortion of the airflow about the aircraft. The Flight Research Laboratory has developed a pod with a Rosemount 858 5-hole probe and

pressure transducers to measure airflow angles and velocities at typical mounting locations on cloud physics research aircraft. This report documents the results of an extensive wind tunnel calibration of this pod to determine the factors relating the differential pressure measurements to the flow angles and velocities, and in particular to account for the effects of the canister itself on these measurements. Author (GRA)

N86-19293# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
ON THE SEPARATED FLOW OVER A DELTA WING AT HIGH SUBSONIC AND TRANSONIC SPEEDS
J. A. MOELLER, W. J. BANNIK, and P. G. BAKKER Dec. 1984 16 p refs Original contains color illustrations
(VTH-M-527) Avail: NTIS HC A02/MF A01

Wind tunnel results on the separated flow over a delta wing at high subsonic Mach numbers (0.55 to 0.85) were obtained for the validation of computer codes based on the Euler flow quations. The two models tested were of the same planform with flat upper surfaces and sharp leading edges, and cropped delta wings with 65 deg leading edge sweep. The larger model had a fuselage extending in front of the wing apex. It was used to study the flow by means of surface oil flow visualization, Schlieren pictures, and 5 hole directional probe flow field surveys at angles of incidence of 0, 5, 15, and 20 deg. With the smaller model, that had no fuselage, vortex breakdown was studied by Schlieren pictures. This model could reach a maximum angle of incidence of 35 deg. Author (ESA)

N86-19294# Technische Hogeschool, Delft (Netherlands).. Dept. of Aerospace Engineering.
ELEMENTS OF THE AERODYNAMIC THEORY OF CYCLOGYRO WING SYSTEMS WITH CONCENTRATOR EFFECTS
R. COENE Oct. 1983 91 p refs
(VTH-LR-338) Avail: NTIS HC A05/MF A01

The fluid dynamics of cyclogyro wing systems are analyzed, based on two-dimensional potential flow theory. General expressions for flows associated with circular distributions of bound vorticity are derived. The forces and moments exerted by the flow on the bound vortices are calculated in their relation with the mass flux and the ground effect. The mean flows generated by wings with constant circulation are used as the environment in which energy exchange related to the shedding of vorticity can take place efficiently. Concentrator effects in the propeller and the turbine case are emphasized. For a wing system operating as a turbine with concentrator effects, the Lanchester-Betz limit for the conversion efficiency, 16/17, is invalid and can be increased. Wing systems operating as a propeller can generate thrust more efficiently when concentrator effects occur. Author (ESA)

N86-19297# Institut Franco-Allemand de Recherches, St. Louis (France).
EXPERIMENTAL AND THEORETICAL STUDY OF INCOMPRESSIBLE FLOW AROUND A WING PROFILE WITH A SPOILER. CONTRIBUTIONS OF LASER VELOCIMETRY AND THE DVORAK METHOD Final Report [ETUDE EXPERIMENTALE ET THEORIQUE DE L'ECOULEMENT AUTOUR D'UN PROFIL D'AILE MUNI D'UN SPOILER D'EXTRADOS EN REGIME INCOMPRESSIBLE; CONTRIBUTION DE LA VELOCIMETRIE LASER ET DE LA METHODE DVORAK]
P. MEYER, G. KOERBER, and R. KAUFFMANN 9 Jul. 1984 133 p refs In FRENCH
(Contract DRET-82-318)
(ISL-R-116/84) Avail: NTIS HC A07/MF A01

The RA16-SCI supercritical profile with spoiler was studied using two dimensional laser velocimetry. The measuring method is described. Experimental results for 3 incidences (10, 20 and 40 deg) and for a three-dimensional configuration are presented. A numerical computing method for separated flow is adapted to the spoiler case. Two types of separations are observed: a single recirculation bubble at 10 deg and the coexistence of two bubbles for 20 and 40 deg. The two components of the velocity field are obtained with good space resolution. The separated flow and the turbulent flow are described with enough detail and reproductibility. Author (ESA)

N86-19298# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
TECHNICAL EVALUATION REPORT ON THE FLUID DYNAMICS PANEL SYMPOSIUM ON AERODYNAMICS AND ACOUSTICS OF PROPELLERS
P. POISSON-QUINTON (ONERA, Chatillon, France) Jul. 1985 43 p refs
(AGARD-AR-213; ISBN-92-835-1508-0) Avail: NTIS HC A03/MF A01

The Advisory Report contains a review and evaluation of the material presented at the AGARD Fluid Dynamics Panel Symposium on Aerodynamics and Acoustics of Propellers held in Toronto, Canada, 1 to 4 October 1984. Also included are related information from other sources and an excellent discussion of the state of art of modern propeller design and performance is presented. This Advisory Report was produced at the request of the Fluid Dynamics Panel of AGARD. Author

N86-19299# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
TRANSONIC UNSTEADY AERODYNAMICS AND ITS AEROELASTIC APPLICATIONS
Jun. 1985 51 p Proceedings of the 59th Meeting of the Structures and Materials Panel, Toulouse, France, 2-7 Sep. 1984
(AGARD-CP-374-ADD-1; ISBN-92-835-1501-3) Avail: NTIS HC A04/MF A01

The 59th meeting of the AGARD Structures and Materials Panel (SMP) was held on 3 to 7 September 1984 in Toulouse, France. It included a specialists' conference to discuss the latest methods of predicting transonic unsteady airloads for oscillating surfaces and flutter. Also considered were aeroelastic applications, many of which were made to standard configurations selected for the SMP cooperative program. The 16 papers and the round table discussion are summarized in some detail for coordination with AGARD's Fluid Dynamics Panel and Fluid Mechanics Panel. Author

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A86-23020
SMALL STONE IMPACT TESTING
R. L. ANDERSON (Rosemount, Inc., Eden Prairie, MN) IN: Institute of Environmental Sciences, Annual Technical Meeting, 31st, Las Vegas, NV, April 30-May 2, 1985, Proceedings . Mount Prospect, IL, Institute of Environmental Sciences, 1985, p. 380-385.

Evaluation of the Foreign Object Damage (FOD) to an aircraft's fragile data instruments and sensitive external hardware is studied. The FOD testing facility, the Centrifugal Stone Accelerator, consists of a rotating motor-driven swingarm with a stone suspended from a flexible steel cable, and a Hall-effect sensor mounted on the DC shaft and hooked up to an RPM counter. The damage effected by a released 'standard stone' object, made of obsidion and about 0.25 oz weight and 0.6 in diameter, traveling at or in excess of 100 mph is assessed. Results of initial tests are presented. I.S.

A86-23800
AN OVERVIEW OF CIVIL HELICOPTER OPERATIONS - PAST, PRESENT AND FUTURE
E. M. BROWN Aerospace (ISSN 0305-0831), vol. 13, Jan. 1986, p. 20, 21, 24-27 .

The designing and developing of helicopters began with the development of the rotary wing. The effect of the turboshaft engine

on helicopter designs is examined. The application of information obtained from military helicopters to civilian designs is analyzed. The development of fiberglass blades allowed for improvements in lift, speed, and fuel consumption, and lowered maintenance costs and noise levels. The uses of helicopters for aerial work, such as crop spraying, filming, inspection, transporting cargo, and for offshore support services are described. The focus of the third generation helicopters is on speed, reliability, safety, and comfort; technological advances in these areas are discussed. The design objectives for the fourth generation helicopters are studied. I.F.

A86-25214#
EFFECTS OF MEASUREMENT ERRORS ON ESTIMATION OF THE PROBABILITY OF VERTICAL OVERLAP
S. NAGAOKA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 378, 1985, p. 403-410. In Japanese, with abstract in English. refs

This paper describes the effects of measurement errors on the distribution of relative vertical distances (RVD) from which the probability of vertical overlap of an aircraft pair can be estimated. As typical examples of probability density functions, the double exponential distribution and the double double exponential distribution are assumed for height keeping errors. Numerical examples suggest that the frequency in the central part (the core region) of RVD distribution in the presence of measurement errors becomes slightly less than that for the case when the measurement errors are not taken into account. On the other hand, the frequency in the tail region becomes slightly greater because of the presence of measurement errors. Author

A86-25849
1985 - A TURNING POINT FOR SAFETY?
D. LEARMOUNT Flight International (ISSN 0015-3710), vol. 129, Jan. 25, 1986, p. 27-32.

The need for stricter safety standards in order to reduce aircraft accidents is discussed. A list of fatal and nonfatal aircraft accidents in 1985 is presented; an increase from 451 deaths in 29 accidents in 1984 to 2,129 deaths in 40 accidents in 1985 is observed. Due to a large number of accidents involving engine failure, the efficiency of jet engine designs and inspection procedures is examined. The role of the US FAA and UK Civilian Aviation Authority in improving and enforcing safety standards are described. I.F.

A86-26127#
A FIRST STEP FOR REDUCING HELICOPTER IFR APPROACH MINIMA AGUSTA A109 IFR CAT II CERTIFICATION
F. BANAL and G. ZANETTI (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Gallarate, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 15 p.

The advantages and drawbacks of lowering the helicopter IFR weather minima using the current ILS system at airports are reviewed. The certification program to obtain FAA STC for IFR CAT II operations of the Agusta A109A, Mk I helicopter is described. It is shown how the flight evaluation results of that program demonstrate the possibility of changing the present helicopter requirements. C.D.

A86-26128#
AIRWORTHINESS ASPECTS OF FATIGUE IN HELICOPTERS
J. W. BRISTOW (Civil Aviation Authority, Airworthiness Div., Redhill, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 14 p. refs

Problems in the current practice of component fatigue substantiation for civil helicopters in the U. K., and CAA guidelines to reduce the relatively high number of accidents (in comparison to that of fixed-wing aircraft), are discussed. An analysis of fatigue-related helicopter failures reveals specific problems such as wear, corrosion, and increased loads that are to be targeted for improvements. Steps taken in the direction of the damage tolerance principles set out in a 1984 report are outlined. They include maintaining existing factor levels on fatigue strength, e.g. 1.6 for aluminum and 1.4 for steel. Where damage tolerance has been shown to be impractical, a more rigorous safe-life substantiation is recommended such as the use of SN curves based on realistically tested components and more representative testing of the magnitude of the loads, the stress distribution, and the number of cycles of helicopter flights. Load spectrum and helicopter failure data are included. R.R.

A86-26151#
DETERMINATION OF LIMITATIONS FOR HELICOPTER SHIP-BORNE OPERATIONS
C. F. G. M. HOFMANN and R. FANG (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 19 p.

The factors influencing helicopter-ship operations are reviewed. The determination of these factors in various qualification program elements and their use in setting up a flight test program aboard ship are examined. The performance of those flight tests and the relevant safety and efficiency constraints are described, and the use during the tests of data obtained in previous program elements in discussed. The application of the test team's previous experience to minimize flying hours without affecting the quality of the test results is examined. C.D.

N86-18306# National Transportation Safety Board, Washington, D. C. Bureau of Technology.
GENERAL AVIATION CRASHWORTHINESS PROJECT, PHASE 3: ACCELERATION LOADS AND VELOCITY CHANGES OF SURVIVABLE GENERAL AVIATION ACCIDENTS Safety Report, 1972-1981
4 Sep. 1985 189 p
(NTSB/SR-85/02) Avail: NTIS HC A09/MF A01

This report is the last in a series of three issued by the National Transportation Safety Board as a result of its General Aviation Crashworthiness Program. Its purpose is to provide information to support changes in crashworthiness design standards for seating and restraint systems in general aviation airplanes. Phase One presents a methodology for documenting impact severity. Phase Two presents specific data on survivable accidents which demonstrate that if all occupants wear shoulder harnesses, fatalities are expected to be reduced by 20 percent. Eighty-eight percent of the seriously injured persons in survivable crashes are expected to experience significantly fewer life-threatening injuries. The Phase Three report provides analytical results of actual crashes. The values of acceleration loads and velocity changes that occupants can sustain in survivable, modern general aviation airplane accidents are defined. This report also discusses specific crashworthiness problems including sea/restraint systems that failed, shoulder harnesses that were not worn, and inadequate or nonexistent seat stroking ability. Author

N86-18307# Naval Research Lab., Washington, D. C.
THE AIRCRAFT ICING ENVIRONMENT IN WINTERTIME, LOW CEILING CONDITIONS Final Report
N. B. GUTTMAN, R. K. JECK, M. R. HENDERSON, and M. D. MUELLER 28 Oct. 1985 74 p
(AD-A160578; NRL-MR-5650) Avail: NTIS HC A04/MF A01 CSCL 09B

Radiosonde (Raob) temperature and humidity data were used to deduce the vertical distribution of clouds and aircraft icing conditions near Washington, D.C. when low ceilings (- or 1000 ft)(0/3 km) occurred along with surface temperatures near freezing. Automated predictions of the vertical distribution of icing probability, type, and severity were generated from the Raob data. The technique employs a U.S. Air Force method that has been computerized by one of the authors (RKJ) for use on Hewlett Packard model 9845 computers. The predictions were compared with pilot reports from the vicinity and reasonable agreement was found. GRA

N86-18308# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

AN ELECTRONIC INDEX OF ARTICLES PERTAINING TO AIR FORCE TRANSPORTATION IN THE POST-WORLD WAR 2 ERA, WITH ABSTRACTS OF SELECTED ARTICLES M.S. Thesis

F. R. ANIBLE Sep. 1985 41 p

(AD-A160837; AFIT/GLM/LSM/85S-1) Avail: NTIS HC A03/MF A01 CSCL 15E

This thesis designed and compiled an electronic index system to catalog articles in military, transportation, and aviation periodicals published during the period 1947 through 1957 and pertaining to transportation and its relationship to the U.S. Air Force. The system consists of a Master Index giving the title, author, publication, and date of over 1,000 articles, with abstracts of selected articles. Separate alphabetical Author, Title, and Subject Indexes are cross-referenced to the Master Index through a simple numerical code system. The indexes are stored on 5-1/4 inch flexible magnetic diskettes which are placed in pockets fastened into the front and back covers of the copy of the thesis kept in the Library of the School of Systems and Logistics, Air Force Institute of Technology. The articles indexed are those dealing with transportation modes and vehicles owned, operated, used, contracted, and leased by the Air force operations. In addition, source pertaining to the interface of Air Force airlift operations and operations of other services are included. GRA

N86-18309# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.

AIRCRAFT ACCIDENT REPORTS: BRIEF FORMATS, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 1 OF 1984 ACCIDENTS

18 Jun. 1985 402 p

(PB85-916920; NTSB/AAB-85/20) Avail: NTIS HC A18/MF A01; also available on subscription, North American Continent $160.00/year; all others write for quote CSCL 01B

Selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1984 are given. The 200 general aviation and air carrier accidents represent a random selection. The facts, conditions, circumstances and probable cause(s) for each accident are given. Additional statistical information is tabulated by type of operation and type of aircraft. GRA

N86-18310# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.

AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT US CIVIL AND FOREIGN AVIATION, ISSUE 2 OF 1984 ACCIDENTS

12 Jul. 1985 406 p

(PB85-916921; NSTB/AAB-85/21) Avail: NTIS HC A18/MF A01; also available on subscription, North American Continent $160.00/year; all others write for quote CSCL 01B

Selected aircraft accident reports are given in a brief format. The accidents occurred in U.S. civil and foreign aviation operations during calendar year 1984. The 200 general aviation and air carrier accidents represent a random selection. The facts, conditions, circumstances and probable causes(s) for each accident are given. Additional statistical information is tabulated by type of operation and type of aircraft. GRA

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A86-22729

THE TELEMETRY SYSTEM OF THE DFVLR EXPERIMENTAL AIRCRAFT ATTAS [DAS TELEMETRIESYSTEM DES DFVLR-FLUGVERSUCHSTRAEGERS ATTAS]

H. BOTHE (DFVLR, Institut fuer Flugfuehrung, Brunswick, West Germany) IN: European Telemetry Conference, 7th, Boeblingen, West Germany, May 21-24, 1984, Reports. Part 2 . Wessling, West Germany, Arbeitskreis Telemetrie, 1984, p. 8.12-8.12.13. In German.

For flight tests related to studies in the area of Flight Mechanics/Flight Control, an aircraft is currently being prepared by a German aerospace company for use as an Advanced Technologies Testing Aircraft System (ATTAS). In a basic stage, the modifications will make it possible to conduct studies related to in-flight simulations, active control, flight control functions with thrust control, cockpit design, 4D control with inclusion of data link, mission management (fuel saving), the operational testing of landing systems, traffic flow control, and data transmission and processing in digital flight control systems (serial bus systems). The modifications needed in the aircraft are discussed, giving attention to the measurement and data transmission system. G.R.

A86-23268

TELEMETRY SYSTEM PROTOTYPE DEVELOPMENT

W. R. HUMMEL (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 17-1 to 17-6.

The Naval Air Test Center at Patuxent River, MD has been using the Real-Time Telemetry Processing System to monitor test flights since 1973. A prototype for its replacement is currently under development. The objectives, design goals, and features of the system are described and compared with the existing system. Author

A86-23376

MODE-S BEACON SYSTEM TO COVER ALL U.S. UPPER AIRSPACE BY 1991

J. L. BAKER (Westinghouse Electric Corp., Pittsburgh, PA), P. N. MCCABE (System Development Corp., Santa Monica, CA), and K. V. BYRAM (FAA, Washington, DC) ICAO Bulletin, vol. 40, Dec. 1985, p. 14-17.

The design of the Mode-S beacon system, which will modernize air traffic control systems by increasing the reporting accuracy of aircraft positions while reducing interference, is studied. The Mode-S system provides monopulse processing, selective interrogation, and a two-way data link. The capabilities of the radio-frequency and pulse processing hardware of the computer controlled interrogator subsystem are examined. The hardware components and functions of the data processing subsystem, which controls real-time scheduling and processing of surveillance and communication data, and communication and surveillance interfacing, are investigated; the subsystem contains transaction processing, monitoring, and data extraction programs. The advantages the Mode-S system provides due to its expandability and flexibility are described. I.F.

A86-23379
SIMPLE TECHNIQUE MOISTUREPROOFS ILS LOCALIZER ANTENNA ARRAY
S. M. IRULAPPAN and S. C. MAJUMDAR (Civil Aviation Department, New Delhi, India) ICAO Bulletin, vol. 40, Dec. 1985, p. 26-28.

A method of protecting the dipole elements of the localizer antenna array from rain and moisture, in order to maintain the performance level, is examined. The requirements for the ILS localizer course alignment and radiation integrity are discussed. The configuration of the antenna's 12 dipole elements, which are mounted in front of a reflector having an 85 ft aperture, is described. The application and installation of 115 cm x 150 cm polyethylene bags over each dipole are analyzed. I.F.

A86-24533
AIRCRAFT APPROACH GUIDANCE USING RELATIVE LORAN-C NAVIGATION
A. L. ELIAS (MIT, Cambridge, MA) Navigation (ISSN 0028-1522), vol. 32, Spring 1985, p. 1-15. refs

Tests performed at, and in behalf of, the State of Vermont led to the first Supplemental Type Certificate for en route use of Loran-C under Instrument Flight Rules. The results of these tests led to a resurgence of interest in the use of Loran-C as a general-purpose national aeronautical radio-navigation system. The main obstacle to the use of Loran-C for final approach to landing guidance is the error due to variations in the propagation speed of the Loran-C signals caused by changes in the terrain's dielectric properties. A 'relative navigation' technique has been proposed for improving the accuracy. The present paper provides the results of two additional studies, taking into account variable signal-to-noise ratio (SNR)/variable acceleration tradeoffs, and small position changes from the reference point. G.R.

A86-25025
INERTIAL NAVIGATION - THE BEGINNINGS OF AN INGENIOUS INVENTION [TRAEGHEITSNAVIGATION - AUS DEN ANFAENGEN EINER GENIALEN ERFINDUNG]
L. SCHMIEDER DFVLR-Nachrichten (ISSN 0011-4901), Nov. 1985, p. 64-67. In German.

The present paper is concerned with the development of inertial navigation, taking into account the time from its invention by Boykow (1911) to the official admission of an inertial platform for U.S. aircraft in the year 1968. It is pointed out that, according to these dates, the development of inertial navigation, from the first concept to technological maturity, has required a time period of 57 years. Attention is given to the article in which Boykow (1911) first describes the characteristics of his new invention and its advantages for the navigation of an aircraft, a patent application submitted by Boykow's company (1926), problems related to friction in the bearings and an approach for overcoming these problems, new advances made by Boykow as incorporated in a patent application (1935), a picture of the inertial platform according to Boykow's concepts, developments related to the 84-minute pendulum, and advances described in a patent applied for by Draper et al. (1951). G.R.

A86-26133#
ANTENNA SITING ON HELICOPTERS
B. AUDONE (Aeritalia S.p.A., Caselle Torinese, Italy) and G. MESCHI (Costruzioni Aeronautiche Giovannia Agusta S.p.A., Cascina Costa, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 17 p. refs

The antenna siting activity on helicopters is described with special attention paid to electromagnetic problems. The importance of the prediction of antenna performances at the early stage of the project is stressed pointing out the importance of computer aids. Test facilities are also described for performing antenna pattern measurements, which represent the most difficult task of the overall activity. Author

N86-18311# National Aerospace Lab., Tokyo (Japan).
CALIBRATION OF AN ON-GROUND AIRCRAFT TRACKING RADAR BY AERIAL PHOTOGRAMMETRY
K. YAZAWA, T. INAGAKI, T. ONO, and T. OKA Jun. 1985 42 p refs In JAPANESE; ENGLISH summary
(NAL-TR-861; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

An on-ground tracking radar is calibrated for obtaining the accurate position of an aircraft during flight testing. The calibration was performed by aerial photogrammetry for estimating the position and the attitude of an aircraft compared with synchronized data from tracking radar. The accuracy of aerial photogrammetry using a non-metric camera is less than 0.2% of the flight altitude from ground. The accuracy corresponds to an angle of 0.01 degree at 1000m height and 10km distance from the radar. It is comparable to the resolution of the radar. Author

N86-18312# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
PROBABILISTIC EVALUATION OF INDIVIDUAL AIRCRAFT TRACKING TECHNIQUES M.S. Thesis
R. L. WILKINSON Sep. 1985 146 p
(AD-A160146; AFIT/GSM/ENS/85S-32) Avail: NTIS HC A07/MF A01 CSCL 01C

A study was conducted in order to demonstrate a technique for comparing the outputs of various individual aircraft tracking (IAT) systems. There were two objectives: (1) to determine the distribution of structural lives that could be expected based on a single IAT scenario, and (2) to evaluate the feasibility of replacing the current universal IAT safety factor with specific statistical calculations that consider the strengths and weaknesses of each IAT system. The ultimate goal of this thesis was to begin the transition of individual aircraft tracking from a deterministic approach to a stochastic one. A simulation was performed which included twelve aircraft, each flying five different load history variations at three gross weights. Initial structural damage was assumed based on a reset flaw size after nondestructive inspection. Structural lives were normally distributed with a mean of approximately 4700 flight hours. The cracks present at the one-half lifetime depot inspection were lognormally distributed. Using these distributions, the probabilities of structural failure were calculated for several inspection intervals. Repeating this process for other IAT scenarios would allow a direct comparison of various IAT systems. Eventually, such a process could lead to individual system safety factors, rather that the current universal safety factor. GRA

N86-19303 New South Wales Univ., Kensington (Australia).
SIGNAL PROCESSING IN THE AIRBORNE RECEIVER OF THE INTERSCAN MICROWAVE LANDING SYSTEM Abstract Only
D. L. DILLON Mar. 1985 3 p
Avail: Issuing Activity

The history and evolution of microwave landing system (MLS) is reviewed. The strategy by which the various MLS functions are sequentially transmitted in accordance with a standardized signal-in-space format is described, making possible the interoperability of ground and airborne subsystems of widely differing sophistication. The meaning of MLS error, its causes and the rationale for the accuracy requirements of the MLS are discussed. The overall task to be performed by the airborne MLS subsystem and the MLS receiver are surveyed. The impact on the processing on MLS signals by interfering propagation effects is considered, together with a review of some MLS signal processing methodologies. A preferred technique is identified. The question of the required sampling rate to implement the signal processing digitally is considered, and a pulse centroid-detection algorithm is described. E.A.K.

N86-19304* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
VIDEO PROCESSOR FOR AIR TRAFFIC CONTROL BEACON SYSTEM Patent
F. BYRNE, inventor (to NASA) 10 Sep. 1985 5 p Filed 28 Sep. 1982
(NASA-CASE-KSC-11155-1; US-PATENT-4,540,986; US-PATENT-APPL-SN-425201; US-PATENT-CLASS-343-6.8-R) Avail: US Patent and Trademark Office CSCL 17G

A circuit is disclosed for use in a transponder located in an aircraft or the like for identifying a true side lobe suppression signal being transmitted by a ground located transmitted system. The true side lobe suppression signal includes at least pulses P1 and P2. The circuit causes the transponder to produce reply signal upon the amplitude of the P1 pulse being a predetermined ratio to said P2 pulse. The circuit includes a pair of transistors with a capacitor connected to the output of the second transistor. The pulses P1 and P2 are supplied to the base electrode of the first transistor. Pulse P1 turns on the two transistors and charges the capacitor to a predetermined level so that when the second pulse P2 arrives, it does not turn on a transistor when it is equal to or less than the first pulse P1.

Official Gazette of the U.S. Patent and Trademark Office

N86-19305# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
AUTOMATIC LANDING THROUGH THE TURBULENT PLANETARY BOUNDARY LAYER
S. ZHU Nov. 1985 305 p refs
(UTIAS-289; ISSN-0082-5255) Avail: NTIS HC A14/MF A01

A statistical approach to automatic landing in turbulent planetary boundary layer is presented which is valuable for use in aircraft design and the analysis of terminal operation safety, also useful in design of autoland systems. The linearized equations of motion for an aircraft following a glide slope and an exponential curved path in the presence of wind shear and turbulence are developed. The effects of gust gradients on the motion were considered. The wind is modeled as a multi-dimensional random process, characterized by the mean wind shear and the turbulence. In the planetary boundary layer the mean wind is adequately described by a power law and by Weibull wind speed distribution. The turbulence is assumed locally isotropic. The modified von Karman model adequately represents correlations along an approach-flare trajectory. The forces and moments are considered to depend linearly on uniform gust and gust gradient components which are obtained by Etkin's four-point method which utilizes the air velocity at 4 points on the aircraft. As a test base, an autopilot of a jet transport for the approach and flare was designed. The Random Choice Direct Search technique was employed to find a set of optimal feedback gains for the auto-flare control system. Author

N86-19306*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HIGH DYNAMIC GPS RECEIVER VALIDATION DEMONSTRATION Final Report
W. J. HURD, J. I. STATMAN, and V. A. VILNROTTER 31 Oct. 1985 208 p refs
(Contract NAS7-918)
(NASA-CR-176530; JPL-PUB-85-74; NAS 1.26:176530) Avail: NTIS HC A10/MF A01 CSCL 17G

The Validation Demonstration establishes that the high dynamic Global Positioning System (GPS) receiver concept developed at JPL meets the dynamic tracking requirements for range instrumentation of missiles and drones. It was demonstrated that the receiver can track the pseudorange and pseudorange rate of vehicles with acceleration in excess of 100 g and jerk in excess of 100 g/s, dynamics ten times more severe than specified for conventional High Dynamic GPS receivers. These results and analytic extensions to a complete system configuration establish that all range instrumentation requirements can be met. The receiver can be implemented in the 100 cu in volume required by all missiles and drones, and is ideally suited for transdigitizer or translator applications. Author

N86-19308# Mitre Corp., McLean, Va.
POTENTIAL APPLICATIONS OF MULTIPLE INSTRUMENT APPROACH CONCEPTS AT 101 U.S. AIRPORTS
A. C. SILVA and J. N. BARRER Sep. 1985 150 p
(Contract DTFA01-84-C-00001)
(AD-A161155; MTR-85W65; FAA-DL5-85-2) Avail: NTIS HC A07/MF A01 CSCL 01E

Concepts for conducting multiple IFR Approaches to airports include: (1) Independent and Dependent parallel approaches at reduced runway separations. (2) Converging approaches to non-intersecting and to intersecting runways. (3) Triple arrival streams to parallel and non-parallel runways. (4) The application of these concepts to the use of separate short runways and segregated traffic streams. This report summarizes a survey of 101 U.S. Airports to determine potential applications of the above concepts. The survey identified many potential applications of each of the concepts using existing runways: (1) Parallel approaches - 25 airports; (2) Converging approaches - 74 airports; (3) Triple approaches - 6 airports; and (4) Use of separate short runways -60 airports. GRA

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A86-23022
SOME THOUGHTS ON THE VIBRATION TESTING OF HELICOPTER EQUIPMENT IN THE UK
J. C. BARKER (Westland Helicopters, Ltd., Yeovil, England) and H. GOLDBERG (GEC Avionics, Ltd., Borehamwood, England) IN: Institute of Environmental Sciences, Annual Technical Meeting, 31st, Las Vegas, NV, April 30-May 2, 1985, Proceedings . Mount Prospect, IL, Institute of Environmental Sciences, 1985, p. 420-430.

The history of the changes in the design requirements set by the Joint Airworthiness Committee for the United Kingdom military helicopters is reviewed, with reference to the mechanical and environmental sources of vibration. Rotor sources are given special attention, while other mechanical components which can induce vibration (shafts, rotor gear boxes, hydraulic pumps, turboengines, tailplanes, and fins) are briefly discussed. Results of a data survey, undertaken to produce quantitative basis for drafting additional specifications, are presented and compared with the old MIL Standard 810D formulae. Based on these results and on comparison with the U.S. helicopters, standards for the minimum-vibration designs, and a new testing philosophy were drafted. A flow chart of testing procedures, and data survey results are included. I.S.

A86-23185#
INFLUENCE OF NONLINEAR BLADE DAMPING ON HELICOPTER GROUND RESONANCE INSTABILITY
D. M. TANG and E. H. DOWELL (Duke University, Durham, NC) Journal of Aircraft (ISSN 0021-8669), vol. 23, Feb. 1986, p. 104-110. refs
(Contract NSF MEA-83-15193)

The lagging motion of each helicopter blade is assumed to be of equal amplitude and equally apportioned phase, thus allowing a simplified analytical method to be used to calculate the ground resonance instability of a helicopter model with nonlinear dampers in both the landing gear and blades. The geometrical nonlinearities of the blade lag motion and the influence of initial disturbances on ground resonance instability are also discussed. Finally an experiment is carried out using a helicopter scale model. The experimental data agree well with analysis. Author

A86-23190#

AEROACOUSTICS OF AN ADVANCED PROPELLER DESIGN UNDER TAKEKOFF AND LANDING CONDITIONS

S. FUJII, H. NISHIWAKI, and K. TAKEDA (National Aerospace Laboratory, Tokyo, Japan) Journal of Aircraft (ISSN 0021-8669), vol. 23, Feb. 1986, p. 136-141. Research supported by the Environment Protection Agency of Japan. refs

Three configurations of six-bladed, 400-mm-diam, scale-model advanced propellers such as backward-, forward-, and back-forward alternately installed swept blades were tested in anechoic environments with an incoming main flow velocity up to 68 m/s. The data for the advance ratio of 0.43-1.15 were obtained in the aeroacoustic aspects. The arrangement of alternately swept blades showed the best quality among the three configurations in the spanwise circulation in the spanwise circulation distribution. The forward-swept blades did not exhibit any aeroacoustic advantage. The alternately swept configuration as a tandem rotation has the potential for decreasing the sound levels at the blade passage frequencies by the dispersion of sound with neither any sacrifice of aerodynamic performance nor mechanical complexity. Author

A86-23191*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

A PROPELLER MODEL FOR STUDYING TRACE VELOCITY EFFECTS ON INTERIOR NOISE

J. R. MAHAN and C. R. FULLER (Virginia Polytechnic Institute and State University, Blacksburg) (Structures, Structural Dynamics, and Materials Conference, 26th, Orlando, FL, April 15-17, 1985, Technical Papers. Part 2, p. 602-608) Journal of Aircraft (ISSN 0021-8669), vol. 23, Feb. 1986, p. 142-147. Previously cited in issue 13, p. 1943, Accession no. A85-30389. refs

(Contract NAG1-493)

A86-23192#

CONTROL OF AEROELASTIC INSTABILITIES THROUGH STIFFNESS CROSS-COUPLING

T. A. WEISSHAAR (Purdue University, West Lafayette, IN) and R. J. RYAN (Rockwell International Corp., Los Angeles, CA) (Structures, Structural Dynamics and Materials Conference, 25th, Palm Springs, CA, May 14-16, 1984, and AIAA, Dynamics Specialists Conference, Palm Springs, CA, May 17, 18, 1984, Technical Papers. Part 2, p. 226-235) Journal of Aircraft (ISSN 0021-8669), vol. 23, Feb. 1986, p. 148-155. Previously cited in issue 13, p. 1914, Accession no. A84-31710. refs

A86-23252

SOCIETY OF FLIGHT TEST ENGINEERS, ANNUAL SYMPOSIUM, 15TH, ST. LOUIS, MO, AUGUST 12-16, 1984, PROCEEDINGS

Lancaster, CA, Society of Flight Test Engineers, 1984, 196 p. For individual items see A86-23253 to A86-23273, A86-23275.

Various papers on flight test technology are presented. The topics addressed include: airborne instrumentation magnetic tape recording through the early 1990s; automated electromagnetic compatibility testing of naval aircraft and integrated avionics; advanced vibration monitoring approach to engine/airframe health and usage monitoring; use of video cassette recorders for combined video and PCM data recording; IFDAPS: hardware and software overview and a user's view; F-16XL flight test overview; infrared instrumentation capabilities at Eglin Air Force Base. Also discussed are: flight test data acquisition and processing system; state of the art computer graphics systems for flight safety monitoring; improved smoke generator for aircraft testing; telemetry system prototype development; intelligent amplifier; inflight resolution evaluation for thermal imaging systems; flight evaluation of a digital electronic engine control; Air Force flight test instrumentation system; and economical in-flight calibration of air data sensors using inertial navigation units as reference. C.D.

A86-23254

AUTOMATED ELECTROMAGNETIC COMPATIBILITY (EMC) TESTING OF NAVAL AIRCRAFT AND INTEGRATED AVIONICS

D. E. TETHER (Veda, Inc., Lexington Park, MD) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 2-1 to 2-7.

The Electromagnetic Compatibility (EMC) testing of Naval aircraft and their associated mission systems is chracteristically as complex as the mission systems being tested and consumes most of the EMC engineers time performing repetitive observations. This paper discusses automation of the repetitive sequences of observations contained in Emission Control (EMCON) and Conducted Emission (CONEM) testing of Naval aircraft and their mission systems. The effects of automation on the continuing escalation in cost of EMC testing are addressed. Author

A86-23260

THE F-16XL FLIGHT TEST PROGRAM

J. N. BOWER and S. R. SCOTT (USAF, Edwards AFB, CA) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 9-1 to 9-5.

This paper presents an overview of the F-16XL Phase I flight test program recently conducted at the Air Force Flight Test center (AFFTC), Edwards AFB, California. The F-16XL was a straight-forward airframe modification of the existing F-16A designed to enhance range, payload and speed capabilities. By retaining the majority of the already-proven F-16A systems, the technical and flight test risks for the F-16XL were significantly reduced compared to similar prototype development programs. Prior to any program decision, it was necessary to demonstrate that the XL design concept improved the operational characteristics of the F-16A while imposing no adverse effects. This could only be accomplished through an extensive flight test program. Author

A86-23267

RESULTS OF HIGH ANGLE-OF-ATTACK TESTING OF THE F-15 WITH CONFORMAL FUEL TANKS

M. D. BASS (McDonnell Aircraft Co., St. Louis, MO) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 16-1 to 16-6.

Results of the high angle-of-attack flight characteristics evaluation of the F-15 equipped with Conformal Fuel Tanks are presented. Testing was accomplished as part of USAF Conformal Fuel Tanks Certification. High angle-of-attack feight characteristics were benign, and similar to the high AOA flight characteristics of the F-15 without Conformal Fuel Tanks. The flight test long noseboom caused adverse high angle-of-attack characteristics. Removal of the noseboom eliminated the adverse characteristics. Future high angle-of-attack test programs should verify the requiement for use of this device. Testing was accomplished without a spin parachute installation on the aicraft, and the cautious approach to testing is documented. Author

A86-23270

ECONOMICAL IN-FLIGHT CALIBRATION OF AIR DATA SENSORS USING INERTIAL NAVIGATION UNITS AS REFERENCE

K.-H. BURGER (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 19-1 to 19-10.

An economical method of aircraft sensor calibration, AUTARK, is described. The method makes it possible to obtain reliable estimates of sensor errors using radar altimeter measurements and navigational data. Among the specific aircraft parameters measured by AUTARK are: the angle of attack, sideslip angle, and fuselage bending due to air loads. The method was evaluated during recent calibrations tests on the Tornado combat aircraft. It

is found that the AUTARK method reduced the number of flying hours required to calibrate aircraft sensors. I.H.

A86-23271

THE ROLE OF THE FLIGHT TEST DEPARTMENT IN THE DEVELOPMENT OF NEW TECHNOLOGY AIRCRAFT

A. J. PUGLIESE (Grumman Aerospace Corp., Bethpage, NY) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 20-1 to 20-8.

In the present discussion of advanced aerodynamic and structural concepts under development, the relationship of developmental experience to the preparation of highly relevant and through, full scale test program is noted and attention is given to multimode flight control system testing and the development of flight test procedures for the analysis and correcting of system failures in flight. The need for instant and reliable emergency power in relaxed stability fly-by-wire aircraft requires through preflight testing and flight planning. The conclusions presently reached concern the management objectives of future flight test programs, regarding the lead time and preparatory measures required for new aircraft. O.C.

A86-23508

ENVIRONMENTAL CONTROL SYSTEM SIMULATION USING EASY5, AS APPLIED TO THE F-14

G. L. HOFFMAN (U.S. Navy, Naval Air Development Center, Warminster, PA) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 15th, San Francisco, CA, July 15-17, 1985. 8 p.

(SAE PAPER 851318)

The Naval Air Development Center has developed a thermal model of the F-14 Environmental Control System (ECS) using the EASY5 dynamic analysis computer program. In addition to discussing the modeling effort, this paper also details several improvements made to the EASY5 program in an attempt to improve its accuracy, flexibility, and computational stability. Also highlighted is a simplified version of the F-14 EASY5 ECS model which is being used to conduct trade studies and to calculate the initial conditions required to run the EASY5 program. Author

A86-23509

DIGITAL CONTROLLED CLOSED LOOP AIR CYCLE DEVELOPMENT

G. S. TSUJIKAWA (Boeing Military Airplane Co., Seattle, WA) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 15th, San Francisco, CA, July 15-17, 1985. 12 p.

(SAE PAPER 851319)

The use of a closed loop environmental control system (ECS) in military aircraft incorporating microprocessor control can reduce engine energy extraction requirements, yielding a reduction in aircraft weight penaltites and/or an increase in range. In addition, chemical and biological warfare threats are reduced and a more favorable thermal environment is obtained for electronics. Attention is presently given to the development of an ECS digital control system whose capabilities have been demonstrated in a laboratory breadboard test rig. O.C.

A86-23510

THE NEW ENVIRONMENTAL CONTROL SYSTEM FOR THE B-52 G/H AIRCRAFT

F. L. BUSCARELLO (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 15th, San Francisco, CA, July 15-17, 1985. 14 p.

(SAE PAPER 851320)

Environmental Control System (ECS) for the B-52 G/H Aircraft The Boeing B-52 G/H aircraft uses precooled engine bleed air as a source for cabin pressurization and cabin, missile and avionics air conditioning. These systems are controlled by two solid state controllers which also contain built in self test and fault isolation. The ECS regulates the bleed air pressure and flow via an electrical signal from a cooling effect sensor in the avionics air supply. This flow control approach saves engine bleed air by not dumping excessive cold air into the avionics equipment and not overcooling or overheating the two cabins or missiles. The missile conditioning system mixes cold and warm air to keep the missiles at the required temperature. The system also provides a 'go-no-go' signal to the cabin to indicate 'temperature readiness' of the missiles. The two cabins are separately temperature controlled through individual temperature selectors and controls. Author

A86-23511

LOW COST THERMAL CONTROL FOR FLIGHT TEST LASER RADAR

A. BRUNS (McDonnell Douglas Astronautics Co., St. Louis, Mo) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 15th, San Francisco, CA, July 15-17, 1985. 11 p.

(SAE PAPER 851321)

As part of an internal program to develop laser radar guidance systems for advanced cruise missiles, a thermal control unit (TCU) was developed for captive flight testing. Requirements of low cost, low maintenance, and small size resulted in the choice of an active, closed-loop, liquid TCU that uses ram air as the heat source or sink. Four coldplates thermally couple the laser to the TCU in the pump-operated liquid cooling reservoir. Four thermoelectric heat pumps mounted on a finned heat sink transfer heat between the liquid loop and the ram air. Temperature sensors downstream of the laser determine the amount of amplifier current driving the thermoelectrics, and whether they should add heat to the coolant or remove it. In flight tests on a King Air aircraft it successfully maintained the laser at + or - 1 C within the operating limits of 27-38 C over all air and ground conditions with a laser heat dissipation load of 200 watts on a 43 C hot day. Performance characteristics of the heating and cooling modes are presented. R.R.

A86-23545

COMPUTER CONTROLLED VARIABLE PRESSURE REDUCING/SHUT-OFF VALVE FOR AIRCRAFT ECS

M. ANDRIANO, V. MARCHIS (Torino, Politecnico, Turin, Italy), and A. MANNINI (Microtecnica-Torino, Turin, Italy) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 15th, San Francisco, CA, July 15-17, 1985. 9 p.

(SAE PAPER 851360)

The present paper reports the development results of a computer controlled variable setting pressure reducing valve (VPRV) designed by Microtecnica and suitable for operation in the latest generation of aircraft ECS. The valves features a double element design, allowing a total independent operation (Shut-Off section and pressure reducing section) offering thereby high reliability and safety. The valve provides wide capability of varying the pressure set point by action of an electric servo and allows considerable weight and energy saving in the ECS design. Results of Experimental Tests performed in the development program are presented in detail. Author

A86-23757

A POSSIBLE APPROACH TO THE DIAGNOSTICS OF THE HYDRAULIC SERVOMECHANISM OF THE AIRCRAFT CONTROL SYSTEM [MOZNY PRISTUP K DIAGNOSTIKOVANIU HYDRAULICKEHO SERVOMECHANIZMU RIADENIA LIETADLA]

A. ZIGO Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1985, p. 185-189. In Slovak.

An approach to the analysis of the performance of the hydraulic servomechanism of the aircraft control system is presented. The approach involves a systematic mathematical analysis of the dynamic characteristics of the individual elements of the hydraulic control system and determination of the intermediate values of certain parameters essential for the reliable operation of the system. The results of the analysis are then used, together with flight operation data, to construct a topological model which provides a

way to determine an optimum set of diagnostic parameters characterizing the technical condition of the system. V.L.

A86-23767

LOCATING AND DEMAGNETIZING MAGNETIZED AIRCRAFT COMPONENTS FOLLOWING A LIGHTNING STROKE [LOKALIZACE ZMAGNETOVANYCH CASTI LETADEL PO UDERU BLESKU A JEJICH ODMAGNETOVANI]

J. HRABAK and K. DRAXLER Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1985, p. 263-265. In Czech.

The physical mechanisms underlying the magnetization of aircraft components affected by a lightning stroke are examined, and methods are presented for locating and demagnetizing such components. A system for locating and demagnetizing lightning-affected parts and components is briefly described. V.L.

A86-23768

METHODS FOR DETERMINING THE WEIGHT AND THE CENTER OF GRAVITY OF AIRCRAFT - THE PLATFORM BALANCE OF THE AERONAUTICAL RESEARCH AND TEST INSTITUTE [ZPUSOBY URCOVANI HMOTNOSTI A POLOHY TEZISTE LETADEL, PLOSINOVE VAHY VZLU]

J. LUKAS and J. VIDIECAN Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1985, p. 267-273. In Czech. refs

The various methods for determining the weight and the center of gravity of aircraft are reviewed with reference to their relative advantages and shortcomings. The platform balance developed by the Aeronautical Research and Test Institute is then described in detail, with attention given to its mechanical and electrical systems, functions, and methods of electrical signal processing. V.L.

A86-23769

A STUDY OF THE SERVICE LIFE OF FAIL-SAFE AIRFRAME STRUCTURES ON THE BASIS OF ROUTINE INSPECTIONS AND CRACK SIZE ASSESSMENT [SLEDOVANI ZIVOTA DRAKU KONSTRUKCI BEZPECNYCH I PRI PORUSE NA ZAKLADE PROHLIDEK A POSUZOVANI VELIKOSTI TRHLIN V PROVOZU]

V. KAHANEK Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1985, p. 275-279. In Czech.

Problems associated with the estimation of the service life of the main airframe structure designed for a safe service life or for fail-safe operation are examined, with particular attention given to the differences between the two design philosophies. While in the former case, only the operating conditions of the aircraft are monitored, in the latter case an aircraft can be taken out of service on the basis of the extent of fatigue damage. V.L.

A86-23799

THE A320 WING - DESIGNING FOR COMMERCIAL SUCCESS

R. F. BACK and J. R. WEDDERSPOON (British Aerospace, Weybridge, England) Aerospace (ISSN 0305-0831), vol. 13, Jan. 1986, p. 12-19.

The development of the wing for the new European aircraft through the collaboration of various European aircraft companies, is examined. The aerodynamic and engineering optimization testing of numerous wing designs to produce a minimum fuel burning aircraft which is easily manufactured, and operational efficient is analyzed. The designing and testing of a high lift system, which included studying leading and trailing edge devices and flap track systems, is described. The high lift system selected for the aircraft is a near full span leading edge over-wing slat with a trailing edge single-slotted flap system across the span, and an underslung beam track system. I.F.

A86-24731#

AEROELASTIC OSCILLATIONS CAUSED BY TRANSITIONAL BOUNDARY LAYERS AND THEIR ATTENUATION

D. G. MABEY, P. R. ASHILL, and B. L. WELSH (Royal Aircraft Establishment, Aerodynamics Dept., Bedford, England) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 49-56. refs

(AIAA PAPER 86-0736)

Recent wind tunnel tests on model wings show large amplitude aeroelastic oscillations in the first bending mode associated with transitional boundary layers. A possible mechanism is suggested, which explains the oscillations primarily in terms of reduced aerodynamic damping. The validity of the hypothesis is confirmed by further measurements, in which the oscillations were attenuated by the installation of a vibration absorber in the hollow wing-tip body. Aeroelastic oscillations caused by transition have implications for the measurement of forces, buffeting and flutter characteristics in wind tunnels (including cryogenic facilities), and for the operation of laminar-flow aircraft. Author

A86-24759*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

HOVER IN-GROUND-EFFECT TESTING OF A FULL-SCALE, TILT-NACELLE V/STOL MODEL

J. E. ESHLEMAN, M. R. DUDLEY (NASA, Ames Research Center, Moffett Field, CA), and C. J. SCHELL (Grumman Aerospace Corp., Bethpage, NY) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 346-360. refs

(AIAA PAPER 86-0780)

A full-scale, tilt-nacelle V/STOL aircraft model was tested in hover at the National Full Scale Aerodynamics Complex (NFAC), NASA Ames Research Center. The model was powered by two TF-34 turbofan engines. It was tested at several ground heights and control deflections. Test technique and test setup were documented. Limited results show that (1) a small change in control power with ground height was measured, and control power was found to be good over + or - 20 deg of horizontal vane deflection; (2) integrated fuselage undersurface pressures, when compared with the total model loads and measured thrust, defined the effect of the fountain and its related flow field on model forces and moments; and (3) there was no indication of hot gas ingestion during simulated takeoff in calm winds from wheels on deck ground height. Author

A86-24988

ONE MAN AND 3,000 MILLION OPERATIONS A SECOND - PREPARING FOR THE LHX COCKPIT

M. LAMBERT Interavia (ISSN 0020-5168), vol. 41, Jan. 1986, p. 27-30.

With the use of the Advanced Rotorcraft Technology Integrator (ARTI), an equipment system is being developed for the mid-1990's for the LHX helicopter to enable single pilot operation of all eight of its scout and attack missions. The system must be capable of executing 3,231 million operations/sec covering navigation, communication, electronic defensive measures, displays, interfaces, target recognition and weapon delivery. If it becomes available, Very High-Speed Integrated Circuitry will make possible a system design of relatively low weight (54 kg), volume, and cost. The system necessitates helicopter design changes to simplify handling, such removal of cross coupling between the axes of control, and creating an optimum combination of side-stick and rudder pedal control. A computer-based Cockpit Emergency Directed Action Program could be used to detect and take action on system faults. Information will have to be circulated over multiple electronic and optical data buses. R.R.

A86-24989
THE HELICOPTER AND THE OTHER VTOL DESIGNS - AN INTERAVIA READER'S MANUAL
N. LAPPOS (United Technologies Corp., Sikorsky Aircraft, Stratford, CT) Interavia (ISSN 0020-5168), vol. 41, Jan. 1986, p. 33-35.

The helicopter's future development and competitiveness with the VTOL are considered. Potential developments in thermodynamic power resulting in the reduction of engine weight will most likely increase safety and maneuverability rather than payload (as already evidenced by the S-70 Black Hawk). The increased use of microelectronics will increase cost efficiency in both design and performance. Advances in rotor technology will have to balance rotor offset and control response with vibration damping. Low-drag helicopters such as the Sikorsky S-76 with cruise speeds of over 180 kn are the model for maximum achievable velocity, while improvements in anti-torque system for tail rotor design will probably achieve sideways speeds of 35 kn. VTOL's such as the tilt-rotor have higher disk loading than the helicopter, and they trade-off higher speed and range against lower hover payload fraction and much larger powerplant weight/power requirements. Other developments including the Sikorsky ABC (using coaxial counter-rotation rotors), and the NASA/Sikorsky X-Wing (with a slotted oval blade-spar cross-section), will not affect the helicopter's projected dominance in payload/trip time/cost for ranges of up to 300 km. R.R.

A86-24990
LAVI - ADVANCED FIGHTER AND INDUSTRIAL SPRINGBOARD
B. WANSTALL Interavia (ISSN 0020-5168), vol. 41, Jan. 1986, p. 77-79, 82, 83.

The estimated $2,200 million program for the development of Israel's Lavi, the first all-CAD/CAM combat aircraft, and its impact on Israeli industry, is discussed. Design choices were dictated by lowest life-cycle costs and the Israeli Air Force requirements for overall aircraft capability in terms of performance, survivability (requiring low radar, IR and visual signatures, built-in passive and active ECM and decoy missiles backed up by Shafrir air-to-air missiles), and sortie generation rate. Operational requirements determined a wing configuration of all-moving canards and a quadruplex digital fly-by-wire control system with full artificial stability. Systems requirements were flexibility and adaptability to upgrading, and avionics used MIL-STD-175OA computers. Four two-seater and two single-seater prototypes are scheduled for test flighting beginning in mid-1986. The U.S. has contributed significant funding for the project and will benefit by substantial subcontracting. Aircraft specifications are included. R.R.

A86-25020
D-CALM - NEW RESEARCH AIRCRAFT FOR REMOTE SENSING [D-CALM - NEUES FORSCHUNGSFLUGZEUG FUER DIE FERNERKUNDUNG]
F. SCHATT (DFVLR, Oberpfaffenhofen, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), Nov. 1985, p. 39, 40. In German.

The 'Department Flight Operations' of the DFVLR received the new research aircraft 'D-CALM' on August 20, 1985. The aircraft is to be employed in operations related to remote-sensing studies conducted by the DFVLR. During the period from 1975 to 1977, the DFVLR has participated, for the first time, in an operational earth reconnaissance project. It was found, that future tasks would require the use of a larger aircraft than the one employed in the first project. In the context of this conclusion, the D-CALM was obtained. The reasons for the selection of the particular type of aircraft chosen are discussed along with a number of modifications which were needed in connection with the functions of the D-CALM as research aircraft. Attention is given to the advantages of the turboprop engines of the new aircraft, the suitability of the aircraft for operations related to oceanography and studies involving flights over extended desert areas, the utilization of a 'wing of new technology' the cabin, the navigation system, and the first operation. G.R.

A86-25024
COMPUTER-AIDED 'SOMATOGRAPHY' FOR THE ERGONOMIC DESIGN OF THE ATTAS EXPERIMENTAL COCKPIT [RECHNERGESTUETZTE SOMATOGRAPHIE ZUR ERGONOMISCHEN GESTALTUNG DES ATTAS-EXPERIMENTALCOCKPITS]
R. UCKERMANN and K. KROHN (DFVLR, Institut fuer Flugfuehrung, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), Nov. 1985, p. 62, 63. In German.

The Advanced Technologies Testing Aircraft System (ATTAS) was obtained by installing suitable equipment on a VFW 614 aircraft, taking into account also appropriate alterations and modifications with respect to the original aircraft structure. ATTAS is to provide a basis for studies of the feasibility of an employment of the most advanced technologies in aircraft. In this context, an experimental cockpit is to be established in ATTAS. In connection with the design of this cockpit, studies involving computer-aided 'somatography' are conducted. According to Jenik and Jenik (1975), 'somatography' is a graphic-constructive method for the representation of schematic pictures of the human figure in significant postures. The objective of the considered approach is the adaptation of the cockpit to the human figure. Attention is given to the functional characteristics of somatography, and the application of these characteristics to the design of the experimental cockpit. G.R.

A86-25089
ROTORCRAFT TRENDS. II - REQUIREMENTS AND MONITORING
T. FORD *Aircraft Engineering (ISSN 0002-2667), vol. 57, Dec. 1985, p. 6-9, 12.*

The use of health monitoring for damage detection in helicopters and to achieve better airworthiness is examined. The importance of visual inspection aids, vibration analysis, and wear debris monitoring in the monitoring process is discussed. The health monitoring requirements for the components of the transmissions, rotor systems, flight control systems, structure, and engines and fuel systems are described. The applications of vibration signal averaging, full flow chip detector, spectrometric oil analysis, ferrographic oil analysis, and introscope inspection to health and usage monitoring of helicopters are investigated, and examples are provded. Author

A86-25095#
COMPARATIVE ANALYSIS OF TWO METHODS FOR EVALUATING THE LOADS ACTING ON THE TAIL PLANE DURING A SYMMETRIC MANOEUVRE
J. BOJANOWSKI and W. LESNIEWSKI Instytut Lotnictwa, Prace (ISSN 0509-6669), no. 100, 1985, p. 3-31. In Polish. refs

The two methods which are compared are those for evaluating the loads acting on the tail plane during a pitching maneuver. The first method is based on the assumed changes of the load factor as a function of time and the other method is based on the assumed changes of the elevator displacement. An equation of short-duration motion is derived with a minimum number of assumptions. The procedure for obtaining the relations used in both cases is presented as well as formulas for computing the loads acting on the tail plane. This computation is performed for a particular type of aircraft over a wide range of altitude and flying speed. The results are presented in a graphical form. Some inferences are drawn as regards the extremum values of the loads acting on the tail plane as obtained by both methods. Author

A86-25096#
AN ANALYSIS OF THE INFLUENCE OF THE DURATION AND SHARPNESS OF A SYMMETRIC MANOEUVRE ON THE LOAD ACTING ON THE TAIL PLANE
J. LAMPARSKI and M. GRABIAS Instytut Lotnictwa, Prace (ISSN 0509-6669), no. 100, 1985, p. 33-47. In Polish.

The load acting on the tail plane during a symmetric maneuver is analyzed for various aircraft types on the basis of the familiar equation of the longitudinal motion of an aircraft given in the NACA Report 1007. The influence of the time in which the maximum

load is attained and of the sharpness of the maneuver on the forces acting on the tail plane is studied. The analysis is performed for each of the aircraft types considered, their centers of gravity being assumed to be located in the middle position. An additional analysis is made for one of them for three locations of the center of gravity. Some conclusions are drawn concerning the influence of the parameters assumed on the forces acting on the tail plane. Author

A86-25180#
EFFECT OF SWEEP ANGLE ON STATIC AEROELASTICITY - THEORY FOR PHYSICAL MEANINGS
S. ANDO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 372, 1985, p. 45-49. In Japanese, with abstract in English. refs

A theory is presented to show simply the essential effect of sweep angle on divergence and aileron reversal. For this purpose, several simplification assumptions are introduced such as high aspect ratio, strip theory of aerodynamics, effective wing root and tip, assumed mode shapes for bending and torsion, etc. Thus, a kind of theory for 'typical section' is developed. The result shows that the divergence speed would be increased and decreased by sweep back and forward, respectively, as is well known. But for aileron reversal, the results seems not to agree with the textbook description. The result obtained here suggests that the reversal speed increases irrespective of sweep back or forward, while the lift due to aileron angle increases and decreases for sweep forward and back, respectively. Author

A86-25188#
ENERGY SAVING IN AIRCRAFT
H. KIMURA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 374, 1985, p. 138-146. In Japanese.

Current status and historical evolution of energy saving systems in aircraft are reviewed. The factors affecting the fuel mileage of aircraft, a method of energy saving, advantages of the turbofan engine for saving fuel cost, and performance characteristics of the fourth generation jet aircraft (Boeing 767) in energy saving are analyzed. The development of the propfan for reducing the fuel cost is emphasized. The contributing factors in reducing the fuel consumption are listed. S.H.

A86-25237#
FIGURES OF OUT SURFACE OF AN AIRPLANE MODEL
M. NAKAMURA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 381, 1985, p. 607-612. In Japanese, with abstract in English. refs

Computational figures of airplane surface are made to match an airplane shape in the sense of sight. The airplane surface is described with a large number of quadrangles which are based on section lines of the airplane. In one concrete example, the section lines of an airplane model are measured. This airplane model is composed of a body, a wing, a tail unit, and two jet engine nacelles. Several figures of the airplane model from various points of view are drawn by using the law of perspective. These figures give clear information of the shape of the airplane model. Author

A86-25423
OPTIMAL LIFTING SURFACES OF WINGS OF COMPLEX CONFIGURATIONS AT SUPERSONIC FLIGHT VELOCITIES [OPTIMAL'NYE NESUSHCHIE POVERKHNOSTI KRYL'EV SLOZHNOI GEOMETRII PRI SVERKHZVUKOVYKH SKOROSTIAKH POLETA]
E. M. PROKHOROV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Nov.-Dec. 1985, p. 154-160. In Russian. refs

The problem of flow past infinitely thin wings, producing only slight perturbations in an ideal gas, is analyzed using a linear formulation. The optimum shape of the wing is determined by finding a function of the local angles of attack which corresponds to a minimum drag coefficient under constraints on the lifting force coefficient and the pitching moment. For a given Mach number, nonseparated flow is realized on an optimal wing, with a zero load on the subsonic leading edge. V.L.

A86-25848
SUPERSONIC PASSENGER DECADE
J. M. RAMSDEN Flight International (ISSN 0015-3710), vol. 129, Jan. 25, 1986, p. 20-25.

The components of the French and British Concordes are described. The fly-by-wire controls of the powered flying control unit, and the nozzles, reheat, and thrust-reversers of the Olympus engines are examined. The problems encountered with the undercarriage are analyzed. The monitoring and maintenance of the aircraft to ensure an adequate service life are investigated. The Concorde's fuel-burn curve and noise level are discussed. I.F.

A86-25925#
STRUCTURAL AIRWORTHINESS - A DECADE OF DEVELOPMENTS
J. W. BRISTOW (Civil Aviation Authority, London, England) (International Federation of Airworthiness, Conference, Amsterdam, Netherlands, Nov. 1985) Tech Air (ISSN 0040-0831), vol. 44, Feb. 1986, p. 1-9. refs

The development of airworthiness standards which will maintain the structural integrity of aircraft and helicopters is discussed. The fail safe and structural integrity audit procedures for monitoring aging aircraft are examined. The use of SN curves and load spectra for fatigue/damage tolerance requirements for helicopter designs is analyzed. The present methods of testing composites and the establishment of working rquirements for the structural design and processing of composite materials are investigated. I.F.

A86-26103#
IMPROVEMENT OF TWO BLADE SECTIONS FOR HELICOPTER ROTORS
K. H. HORSTMANN, H. KOESTER (DFVLR, Brunswick, West Germany), and G. POLZ (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 14 p. refs

Attention is given to recently developed advanced airfoils for helicopter rotor blades which have been subjected to theoretical and experimental investigations with a view to performance refinement. Near-root airfoil lift coefficients at low Mach numbers and tip airfoil drag rise numbers have both been increased in this fashion. Performance comparisons are made between the present, improved airfoils and their original form, as well as with the classic NACA 23012 profile. O.C.

A86-26104
AN EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF A RANGE OF AEROFOIL DESIGN FEATURES ON DYNAMIC STALL ONSET
P. G. WILBY (Royal Aircraft Establishment, Farnborough, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 17 p. refs

Data from oscillatory pitch tests are used to evaluate the maximum value of incidence that can be attained without incurring stall during the cycle. It is deduced that, for the 12-percent thick airfoils, when stall is first encountered (as mean incidence is increased), stall is triggered by a rear separation. Data from tests at constant pitch rate are then examined, and it is seen that, at low pitch rates, stall is triggered by a rear separation for the thicker airfoils. However, the rear separation is progressively suppressed as pitch rate increases, allowing a greater incidence to be attained before stall occurs, until eventually leading edge separation provides the trigger. For an 8 percent thick airfoil, stall is triggered by a leading edge separation under all conditions. Author

A86-26105*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

APPLICATIONS OF AN ANALYSIS OF AXISYMMETRIC BODY EFFECTS ON ROTOR PERFORMANCE AND LOADS

W. JOHNSON and G. K. YAMAUCHI (NASA, Ames Research Center, Moffett Field, CA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 23 p. refs

A computationally efficient body analysis is developed and coupled with a comprehensive helicopter analysis to calculate the body-induced aerodynamic effects on rotor performance and loads. A modified slender body theory is used as the body model. With the objective of demonstrating the accuracy, efficiency, and application of the method, the analysis at this stage is restricted to axisymmetric bodies at zero angle of attack. By comparing with results from an exact analysis for simple body shapes, it is found that the modified slender body theory provides an accurate potential flow solution for moderately thick bodies, with only a 10-20 percent increase in computational effort over that of an isolated rotor analysis. The computational ease of this method provides a means for routine assessment of body-induced effects on a rotor. Results are given for several configurations that typify those being used in the NASA Ames 40 x 80-ft Wind Tunnel and in the rotor-body interference tests being conducted at NASA Ames. Author

A86-26113*# Massachusetts Inst. of Tech., Cambridge.

A THEORETICAL ANALYSIS OF THE EFFECT OF THRUST-RELATED TURBULENCE DISTORTION ON HELICOPTER ROTOR LOW-FREQUENCY BROADBAND NOISE

M. WILLIAMS and W. L. HARRIS (MIT, Cambridge, MA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 14 p. refs

(Contract NSG-1583)

The purpose of the analysis is to determine if inflow turbulence distortion may be a cause of experimentally observed changes in sound pressure levels when the rotor mean loading is varied. The effect of helicopter rotor mean aerodynamics on inflow turbulence is studied within the framework of the turbulence rapid distortion theory developed by Pearson (1959) and Deissler (1961). The distorted inflow turbulence is related to the resultant noise by conventional broadband noise theory. A comparison of the distortion model with experimental data shows that the theoretical model is unable to totally explain observed increases in model rotor sound pressures with increased rotor mean thrust. Comparison of full scale rotor data with the theoretical model shows that a shear-type distortion may explain decreasing sound pressure levels with increasing thrust. Author

A86-26115#

PREDICTION OF AUDITORY MASKING IN HELICOPTER NOISE

G. M. ROOD (Royal Aircraft Establishment, Human Engineering Div., Farnborough, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 17 p. refs

A research program was initiated with the objective to predict to a degree of accuracy the masked thresholds of listeners under high noise conditions. Existing models were extended and modified to cover aspects of military operations both in helicopters and fixed wing aircraft. The present paper provides a description of research regarding the application of the auditory model, giving attention to the conclusions of the research with respect to real-life helicopter noise and operational conditions. A basic auditory filter model was used in the determination of the masked auditory threshold from experiments carried out in the helicopter noise simulator. The basis of the conducted experiment was to measure the auditory threshold of a number of subjects to a range of pure tone frequencies whilst exposing the subjects in the helicopter noise simulator to 'real-life' noise conditions. G.R.

A86-26116#

DESIGN OF THE 225-KNOT CONVENTIONAL ROTOR

F. J. MCHUGH (Boeing Vertol Co., Philadelphia, PA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 25 p. refs

A study on the baseline definition of the advanced flight research rotor (AFRR) of 225 km maximum efficiency cruise speed, and a few details on sensitivity study results and the preliminary design, are presented. The study ground rules were for a four-blade rotor with drag loading of 1500 lb/sq ft, an advancing-tip Mach number limit of 0.9, disk loading of 6.25 lb/sq ft, and Mangler 1 loading. The airfoils were operated at maximum lift to drag. Recommendations include: thrust weighting to define the blade chord; a blade planform with an inverse taper to 88 percent and conventional taper to the tip to provide the maximum rotor lift to equivalent drag (L/DE); and inboard blade stiffness out to 60 percent to reduce the twist requirement. Furthermore, the elastic twist is basically first and second harmonic with a very small amount of third harmonic, and it is mandatory to match the optimum pitch on the advancing side of the rotor to maximize performance. The recommended blade with a L/De of 9.1 shows a 60 percent improvement from the CH-46E reference rotor, and its development has been determined to be feasible. R.R.

A86-26117#

ROTORCRAFT STRUCTURAL DYNAMIC DESIGN MODIFICATIONS

S. V. HANAGUD, M. MEYYAPPA, Y. P. CHENG, and J. I. CRAIG (Georgia Institute of Technology, Atlanta) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 14 p. refs

(Contract DAAC29-82-K-0094)

At present, most of the structural dynamic design modifications are being done primarily by the use of analytical finite element modelling techniques. Design verifications and testing are accomplished by tests on the full scale rotorcraft with and without modifications. This limits the options for such design modifications. The responsibility primarily lies on the analytical modelling capability. In this paper, a different approach that complements the analytical modelling has been suggested. This approach is by the use of structural dynamic physical scale models, optimization techniques with frequency constraints and general structural dynamic system identification techniques. Author

A86-26119#

INVESTIGATION ON A SMALL SCALE MODEL OF DUCTED COMPOSITE COUNTERROTATING ROTOR

D. DINI (Pisa, Universita, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 10 p.

A design feature and prospective performance study is conducted for a novel helicopter configuration in which counterrotating, high solidity rotors are located fore and aft above the fuselage within small diameter ducts. Experimental data obtained with small scale models indicate sufficient dynamic stability in forward flight and maneuvering, on the basis of separate use of the rotors and auxiliary jet power. Increased aerodynamic drag due to the rotor duct limits forward speed, however, so that variable geometry stator vanes under the rotors are required for the generation of lifting flow. O.C.

A86-26120*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
APPLICATIONS OF NUMERICAL OPTIMIZATION METHODS TO HELICOPTER DESIGN PROBLEMS - A SURVEY
H. MIURA (NASA, Ames Research Center, Moffett Field, CA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 22 p. Previously announced in STAR as N85-10036. refs

A survey of applications of mathematical programming methods is used to improve the design of helicopters and their components. Applications of multivariable search techniques in the finite dimensional space are considered. Five categories of helicopter design problems are considered: (1) conceptual and preliminary design, (2) rotor-system design, (3) airframe structures design, (4) control system design, and (5) flight trajectory planning. Key technical progress in numerical optimization methods relevant to rotorcraft applications are summarized. M.A.C.

A86-26123#
OPTIMUM HELICOPTER IN THE FLIGHT SPECTRUM
A. RUSSO, G. BONAITA, M. CRESPI, and S. PANCOTTI (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Gallarate, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 22 p. refs

Attention is given to an optimization technique for helicopter design that encompasses all fundamental parameters of the vehicle; the energy function used allows an averaging of design features, among different anticipated flight conditions for the given performance spectrum or mission profile, with the desired level of importance. For multimission or multi-flight spectrum cases, there exist many optimization strategies based on a pseudoenergy function. Attention is presently given to redundancies among the elements to be optimized, and to elements that significantly reduce total energy. Design differences between conventionally defined and optimized helicopters are noted. O.C.

A86-26124#
THE PROJECT FOR ANTI-TANK HELICOPTER
G. BOLOGNA and A. GIOVANNINI (Agusta S.p.A., Milan, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 25 p.

The performance, low detectability, high survivability and weapons platform effectiveness criteria that were used in the design optimization of the dedicated antitank A-129 helicopter are discussed, in the context of the most probable NATO battle scenarios. The design of a multirole helicopter that could be adapted for antitank use by means of a kit was rejected in favor of an antitank weapons platform; iterative tradeoff studies resulted in an exceptionally small and light aircraft extensively using primary structure composites. The effects of missile and small arms threats to such a helicopter are discussed from the viewpoints of powerplant, transmission, rotor, flight control system, and other vulnerabilities. Armor and crashworthiness design considerations are also noted. O.C.

A86-26126#
IMPACT OF ADVANCED TECHNOLOGY ON FUTURE HELICOPTER PRELIMINARY DESIGN
J. P. ROGERS, R. A. SHINN, and R. L. SMITH (U.S. Army, Directorate for Advanced Systems, St. Louis, MO) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 16 p.

The impact of advanced technology on size and weight of future helicopters was investigated by conducting preliminary design studies for a conventional helicopter configuration designed with 1970's technology, and again with predicted near-term advanced technology levels. The advanced technologies considered in the study include composite structures, advanced engines, digital/optical flight controls, advanced weaponry, and advanced rotor technology. The predicted effect of these advanced technologies on future helicopter rotor performance, airframe weight, installed power, and subsystems weight is presented, as are trends of engine and vehicle sizing with drag reductions. Finally, the integrated effect of across-the-board application of advanced technology on future helicopter preliminary design sizing is presented. The results demonstrate the significant reductions in airframe and engine size and weight that advanced technology will provide for future rotorcraft concepts. Author

A86-26138#
FEASIBILITY OF SIMPLIFYING COUPLED LAG-FLAP-TORSIONAL MODELS FOR ROTOR BLADE STABILITY IN FORWARD FLIGHT
G. R. NILAKANTAN (Hindustan Aeronautics, Ltd., Bangalore, India) and G. H. GAONKAR (Indian Institute of Science, Bangalore, India) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 32 p. refs

Feasibility of simplifying coupled lag-flap-torsional models is explored for the low-frequency stability of isolated hingeless rotor blades in forward flight. The non-linear equations of moderate deflections with appropriate geometric nonlinearities are valid to third order, so are the perturbed linear equations about time dependent equilibrium (trim) positions. Aerodynamic strip theory based on a quasisteady approximation of two-dimensional unsteady airfoil theory is used. Under linear and quasilinear propulsive trim conditions, stability is investigated for four cases: a base-line model with elastic lag bending, flap bending and torsion degrees of freedom, the modified elastic lag-flap model that neglects only torsional dynamic effects, and the rigid blade models with and without quasisteady approximation to torsion. The method of equivalent Lock number and drag coefficient is used for qualitative insights into dynamic inflow effects. The range of validity of the modified elastic lag-flap and rigid lag-flap models is outlined with respect to torsional frequencies for soft (including matched stiffness) and stiff inplane rotors. Author

A86-26139#
A NONLINEAR MODEL OF AEROELASTIC BEHAVIOUR OF ROTOR BLADES IN FORWARD FLIGHT
A. ROSEN and O. RAND (Technion - Israel Institute of Technology, Haifa) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 20 p. refs

The paper presents a nonlinear model of the aeroelastic behavior of rotor blades. This model is based on two submodels. The first one is a nonlinear structural/dynamic model while the second is a prescribed-wake unsteady aerodynamic model. The paper concentrates on the method of combining these two submodels. Since these submodels are nonlinear and the steady state is of nonlinear periodic nature, there are certain difficulties in obtaining the final complete aeroelastic response. The paper presents the iterative interactive approach which has been developed and discusses the different problems associated with this model. Two examples are presented where the theoretical results are compared with existing experimental results. It is shown that good agreement is obtained in most of the cases. Author

A86-26141*# California Univ., Los Angeles.
AEROMECHANICAL STABILITY ANALYSIS OF A MULTIROTOR VEHICLE WITH APPLICATION TO HYBRID HEAVY LIFT HELICOPTER DYNAMICS
C. VENKATESAN and P. P. FRIEDMANN (California, University, Los Angeles) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 27 p. refs
(Contract NAG2-116)

The Hybrid Heavy Lift Helicopter (HHLH) is a potential candidate vehicle aimed at providing heavy lift capability at low cost. This vehicle consists of a buoyant envelope attached to a supporting structure. Four rotor systems are also attached to the supporting

structure. Nonlinear equations of motion capable of modeling the dynamics of this multi-rotor/support frame/vehicle system have been developed and used to study the fundamental aeromechanical stability characteristics of this class of vehicles. The mechanism of coupling between the blades, supporting structure and rigid body modes is identified and the effect of buoyancy ratio (buoyant lift/total weight) on the vehicle dynamics is studied. It is shown that dynamics effects have a major role in the design of such vehicles. The analytical model developed is also useful for studying the aeromechanical stability of single rotor and tandem rotor coupled rotor/fuselage systems. Author

A86-26142#

ANALYTICAL AND EXPERIMENTAL RESULTS OF THE GROUND RESONANCE PHENOMENON FOR A.129

ORLANDI, A. CERIOTTI, A. RUSSO, MARCHESE, MAINO (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Gallarate, Italy) et al. Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 37 p. refs

The paper presents the methodology used in AGUSTA to investigate the Ground Resonance problem. The following three phases of the methodology are considered: design definition, analytical/experimental stage, and ground resonance tests. Emphasis is placed on the second phase, with a description given of the ground vibration tests and their results for the experimental part, the two computer codes used with results, and comparisons between them for the analytical part. For the third phase, the initial results of ground resonance tests are shown, and the procedure for the analysis of the signals obtained from these tests is described. All the results and the data of the work refer to the new AGUSTA 129, so they are not complete as the helicopter is still in the prototype phase. Author

A86-26143#

NONLINEAR ANALYSIS FOR DYNAMIC BEHAVIOURS OF A COUPLED ROTATIONAL VIBRATION SYSTEM NEAR ITS CRITICAL SPEED

T. NAGASHIMA and Y. KATO (Defense Academy, Yokosuka, Japan) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 18 p. refs

From a viewpoint of the nonlinear mechanics, theoretical analyses for dynamic behaviors of an unbalanced rotor near its critical speed are carried out, with emphasis on the variation of rotor speed. A numerical method to construct solutions of autonomous, nonlinear, two-degrees-of-freedom differential equations as trajectories upon the reduced phase plane is proposed. It is understood that basic features of dynamic behaviors near the critical speed should be attributed to properties of pumping phenomena, the relaxational energy transformation between rotational and translational motions. Periodic solutions existing in this nonlinear system are determined numerically by the single and the multiple closed trajectories which could be referred as the specified space filling curves in ergodic space. Analytical approaches utilizing the Fourier expansion method are also presented and dependencies of periodic solutions on their initial conditions as well as the nonlinearity parameter are clarified. The existence of another kind of periodic solutions is suggested with relation to the diverged trajectories where the rotational motion of unbalanced rotor is degenerated to the reciprocating one. Author

A86-26144*# *National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.*

HOVER TEST OF A FULL-SCALE HINGELESS ROTOR

W. WARMBRODT and R. L. PETERSON (NASA, Ames Research Center, Moffett Field, CA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 24 p. Previously announced in STAR as N84-33401. refs

The performance and aeroelastic stability in hover of a 9.8-m diameter, hingeless helicopter rotor system was evaluated. Rotor performance and inplane damping data were obtained for rotor operation beteen 350 and 425 rpm for thrust coefficients (CT/sigma) between 0.0 and 0.12. At constant rotor thrust, a minimum in rotor inplane damping was measured at 400 rpm. Good agreement is shown between experimental performance data and predicted performance. The influence of different aerodynamic inflow models on predicting damping levels is also shown. The best correlation with experimental stability data was obtained when a dynamic inflow model was used instead of static or quasistatic inflow models. Comparison with other full scale, hingeless rotor data in hover is presented. The hingeless rotor data and data from a full scale, bearingless main rotor test performed on the same general purpose test apparatus were compared. Although the bearingless rotor was more highly damped at design tip speed and 1-g thrust operation, greater sensitivity to operating conditions is shown. At low thrust levels the bearingless main rotor is less damped than the hingeless rotor. E.A.K.

A86-26145#

STUDIES OF ROTORCRAFT AGILITY AND MANEUVERABILITY

H. C. CURTISS, JR. (Princeton University, NJ) and G. PRICE (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 22 p. refs

Current rotorcraft maneuverability models are derived from high speed fixed-wing simulations and do not accurately represent the unique maneuvers or limits associated with rotorcraft. Two simplified rotorcraft models are derived which are valid at low speeds and in uncoordinated flight and can be used to examine some of the fundamental aspects of maneuverability and agility. The approach taken is to separate the total induced power and propulsive power above that for steady level flight from the usual expression for total power required. The sum of the induced and propulsive power is then expressed in terms of the horizontal and vertical accelerations in the maneuvering state. Maneuver limits can then be calculated in terms of vehicle design parameters. At low speeds, the attainable levels of acceleration, deceleration, climb, and load factor depend on available control power, control rates, and pilot limits as well as installed power. Because of the direct connection between body attitude and acceleration, it is suggested that an auxiliary thruster would increase vehicle agility, especially at low speeds. Author

A86-26146#

A COMPUTER BASED STUDY OF HELICOPTER AGILITY, INCLUDING THE INFLUENCE OF AN ACTIVE TAILPLANE

S. HOUSTON and A. E. CALDWELL (Glasgow, University, Scotland) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 18 p. refs

A computer-based study of combat-helicopter agility in longitudinal maneuvers is presented, comparing the agility ratings of four helicopters with the same stiff-flapwise rotor and speed (185 km/hr), but different horizontal tailplane configurations. Agility is quantified by the geometry of the maneuver and the time taken to perform it, subject to the limiting hub moment. Vehicle equations solved using an inverse method determined that the helicopter with a controllable tailplane, as the most agile, could fly bobups to 50 m up to 10 percent more quickly than the fixed-tail/least agile one, and hence required less airspace to maneuver. Because the control law is a function of the three tail rotor controls and the pitch rate, it is suggested that such a tailplane would need to be actively controlled, and an integrated element of the helicopter flight control system. R.R.

A86-26157#
ELECTRICAL CONNECTIONS AND ANTENNA PERFORMANCE OF A LARGE COMPOSITE FUSELAGE MODULE IN THE HIGH FREQUENCY RANGE
M. J. HESELTINE and W. G. BOUGHTON (Westland Helicopters, Ltd., Yeovil, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 14 p.

The utilization of carbon fiber composites in the design of airframes presents certain problems from an electrical point of view. The present paper is concerned with investigations which were conducted with respect to these problems, taking into account comparative measurements undertaken with an HF antenna fitted to an equivalent metal structure and subsequently onto an Advanced Technology Fuselage (ATF). It was found that an HF antenna mounted on a carbon fiber ground plane exhibits greater losses than the same antenna mounted on a similar sized metal ground plane at frequencies in the range from 2 MHz and 30 MHz, taking into account the use of low current measurement techniques. G.R.

A86-26161#
A REVIEW OF RAE EXPERIMENTAL TECHNIQUES FOR ROTOR DYNAMICS AND AERODYNAMICS
F. B. MOULANG (Royal Aircraft Establishment, Bedford, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 18 p. refs

The development of RAE in-flight experimental techniques for flight research into the detailed aerodynamics, blade motion, structural loading, and temperature distribution of helicopter rotors is reviewed, with emphasis on the most recent employment of data acquisition systems. Main rotor blade modification procedures for mounting strain gages and pressure sensors (stressing the 'glove' technique), in addition to their requirements for flight safety and airworthiness, are discussed. The signal conditioning circuitry uses multichannel slip ring assemblies to supply power to the rotor head and address the sensor amplifiers. The introduction of digital magnetic tape as the prime recording medium alloys data acquisition at a high rate as required by the rotor dynamics. The development of DATAMAP, allowing the generation of a wide variety of display formats, will make possible the direct comparison of measured and predicted data. A special chamber was constructed for the calibration of the large number of sensors involved. R.R.

A86-26162
TESTS ON A NEW DYNAMICALLY SCALED MODEL ROTOR IN THE RAE 24 FT WIND TUNNEL
J. T. CANSDALE, R. J. MARSHALL, and P. A. THOMPSON (Royal Aircraft Establishment, Farnborough, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 19 p. refs

A new dynamically scaled rotor has been developed for the RAE model rotor rig in the 24ft Wind Tunnel. Two trials have been conducted during 1983, with the aim of acquiring experimental data for validation of loads prediction methods and guiding their further development. Major features of the 3.6 m diameter rotor are the composite blades with RAE 9642 section and built-in twist, and the dual load path hub. The latter is readily adaptable to allow variation of basic design parameters. The design and development of the rotor system is described, together with other new experimental equipment such as the data acquisition system. The trials are summarised, and a selection of results are presented covering loads measured in both the primary and secondary load path components. Comparable theoretical predictions are presented and discussed. Plans for further developments of the test facility and the rotor itself are outlined. Author

A86-26163#
DESIGN AND TESTING OF A LARGE SCALE HELICOPTER FUSELAGE MODEL IN THE RAE 5 METRE PRESSURIZED WIND TUNNEL
F. T. WILSON (Westland Helicopters, Ltd., Yeovil, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 16 p.

The design and preliminary results of a helicopter fuselage wind tunnel experiment to study the influence of Reynolds number on a number of important airframe aerodynamics parameters are discussed. High Reynolds number testing has been identified as a requirement to optimize aerodynamic design and minimize drag for future helicopter designs. A versatile helicopter-airframe-test rig was built to support the various large-scale fuselage and cowl shapes to be tested, and to provide a means to measure rotor head forces and moments. Preliminary small-scale low Reynolds number tests determined the optimum configuration for the study, which used a 5/16 scale in a 5 m wind tunnel over a range of Reynolds numbers from 2.46 times 10 to the 6th per meter, to 17.44 times 10 to the 6th per meter. An RTM 322 engine and a gearbox size no greater than that of the W30 were assumed, and a rigid five bladed rotor head was used for this first test. No unexpected Reynolds number effects on fuselage/cowl longitudinal characteristics were noted, but large changes in rotor head drag with Reynolds number, and some 'critical' drag changes were observed. R.R.

A86-26164#
TESTS ON WHOLE A129 ENGINE BAY SIMULATING THE INERTIA AND AERODYNAMIC LOADS
G. GODIO (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Gallarate, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 11 p.

These experimental tests are conducted to verify the safety of engine bay of the A129 helicopter in the event of fire. The importance of loads application during the tests are fundamental, because they allow the integrity of engine bay and underlying frame to be checked under actual flight conditions during fire hazard. The inertia loads simulation is carried out with hydraulic cylinders, while the aerodynamic loads are simulated with fans. The engine inlet and outlet are simulated with air flow. The tests are conducted with diffuse flame to verify the engine bay capability to contain the flame and with concentrate flame to verify the strength of installation parts under load. These results make it possible to warranty the safety of engine installation under all fire conditions and to optimize traditional and new materials. Author

A86-26165#
SIMULATION CONCEPTS AND TESTING OF THE TAIL ROTOR FLY-BY-WIRE SYSTEM OF THE A129 HELICOPTER
M. ZAVA and G. MARIANI (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Gallarate, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 18 p.

Attention is given to simulation concepts developed for the A129 antitank helicopter's fly-by-wire tail rotor system, and to the importance of its interconnection with the redundancy management capabilities of the A129's Integrated Multiplex System. The simulation focuses on system responses to both hydraulic and electronic failures; the software and hardware employed in the simulation testing process are noted, with emphasis on features dedicated to failure simulation. The results obtained are subjected to critical evaluation. O.C.

A86-26167#
HC-MK1 (CHINOOK) HEATED ROTOR BLADE ICING TEST. I - TEST VEHICLE, TEST SITE, APPROACH AND SUMMARY OF TESTING
K. LUNN (Boeing Vertol Co., Philadelphia, PA) and R. CURTIS (Aeroplane and Armament Experimental Establishment, Boscombe Down, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 17 p. refs

Extensive modifications made on a standard HC-MkI Chinook helicopter to provide a test vehicle that could take full advantage of available natural icing conditions are described. Reasons for selecting CFB Shearwater in the Canadian Maritimes as the test site are discussed and data to support this choice are presented. The performance of the tests is briefly described. C.D.

A86-26168#
HC-MK1 (CHINOOK) HEATED ROTOR BLADE ICING TEST. II - ANALYSIS OF ATOMOSPHERIC CONDITIONS, AIRCRAFT AND SYSTEMS CHARACTERISTICS
P. DUNFORD (Boeing Vertol Co., Philadelphia, PA) and R. FINCH (Aeroplane and Armament Experimental Establishment, Boscombe Down, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 25 p. refs

Procedures to develop and optimize the HC-Mk1 (Chinook) heated rotor blade device system are presented and discussed. Analytical aspects of the test program are covered with special emphasis on the analysis techniques employed to process performance, flight loads, and blade temperature data in flight. Trial results from the latest winter trials are presented, and plans for next winter's testing are outlined. C.D.

A86-26169#
HELICOPTER VIBRATION FLIGHT TESTING - THE ROTORTUNER APPROACH
N. TRIGG (Helitune MCT, Ltd., Fleet, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 21 p.

A cost-effective and timely means of helicopter vibration management and research using the Rotortuner is described. The problem of helicopter vibration and the basic requirements of a vibration management system are summarized, and the advantages and disadvantages of existing equipment for vibration management are described. The main features of the Rotortuner system are presented, and their operation is briefly described. C.D.

A86-26299
TOMORROW . . . CONCORDE'S SUCCESSOR?
G. CORMERY (Aerospatiale, Division Avions, Paris, France) and G. PATRI Revue Aerospatiale (ISSN 0065-3780), Feb. 1986, p. 10-15. In English and French.

The current state-of-the-art in supersonic transport is discussed along with studies for the development of the Future (second-generation) Supersonic Transport (FSST). Technological advances flight-proven in Concorde's 10 years of commercial experience include full-authority fly-by-wire controls on all three axes and on the engine, digital computers, and an automatic flight management system. Studies for the development of an FSST center on wind-tunnel model testing using the following parameters: Mach 2-2.2, 50 percent aerodynamic, propulsion and weight improvement over the Concorde, an 8000 km/200 passenger profile with 1000 km subsonic flight, the use of existing airport installations, and ICAO A.16.1971 subsonic aircraft noise limitations. The adoption of a variable-cycle engine providing a bypass flow at subsonic regimes and a single flow for supersonic flight will provide the best compromise between general performance and noise limitations. Other projected technologies include the extensive use of the control-configured vehicle concept, permitting flight with zero static margins. R.R.

N86-18316# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
EFFECTIVENESS OF FATIGUE LIFE ENHANCING FASTENERS IN THE DESIGN AND REWORK OF AIRCRAFT STRUCTURES Final Report, Feb. 1982 - Feb. 1985
P. A. KOZEL 28 Feb. 1985 31 p
(Contract F41-420)
(AD-A159676; NADC-85112-60) Avail: NTIS HC A03/MF A01 CSCL 13E

Fatigue life data were obtained for four different types of fatigue life enhancing (FLE) fasteners installed in new uncracked holes and in reworked, pre-cracked holes. The first condition represented a new design where the FLE fasteners are installed during production. The second condition represented a structural rework in which fastener holes are reamed to a larger size to remove fatigue or fretting damage but might still contain a small undetected crack. Results showed that the FLE fasteners produced approximately the same overall fatigue life in the new design and the rework condition and provided a significant increase in life compared to conventional non-FLE fasteners. Tests were performed with 7075-T6 aluminum alloy under spectrum loading typical of a Navy fighter/attack type of aircraft. For the rework condition, the pre-crack size was limited to .03 inch (.76mm). Flush head fasteners were used in all tests. GRA

N86-18317# Army Aviation Research and Development Command, Moffett Field, Calif. Aeroflightdynamics Directorate.
EFFECTS OF BLADE-TO-BLADE DISSIMILARITIES ON ROTOR-BODY LEAD-LAG DYNAMICS
M. J. MCNULTY 1985 29 p
(AD-A160497) Avail: NTIS HC A03/MF A01 CSCL 01C

Small blade-to-blade property differences are investigated to determine their effects on the behavior of a simple rotor-body system. An analytical approach is used which emphasizes the significance of these effects from the experimental point of view. It is found that the primary effect of blade-to-blade dissimilarities is the appearance of additional peaks in the frequency spectrum which are separated from the conventional response modes by multiples of the rotor speed. These additional responses are potential experimental problems because when they occur near a mode of interest they act as contaminant frequencies which can make damping measurements difficult. The effects of increased rotor-body coupling and a rotor shaft degree of freedom act to improve the situation by altering the frequency separation of the modes. Author (GRA)

N86-18318# Mechanical Technology, Inc., Latham, N. Y.
INTERACTIVE EFFECTS OF HIGH- AND LOW-FREQUENCY LOADING ON FATIGUE Final Technical Report, 1 Sep. 1982 - 31 Dec. 1984
A. PETROVICH May 1985 158 p
(Contract F33615-82-C-5056)
(AD-A160601; MTI-85TR48; AFWAL-TR-85-4045) Avail: NTIS HC A08/MF A01 CSCL 20K

This report describes the results of a program to measure and model the controlling mechanisms of fatigue and creep-crack growth behavior of a typical aircraft engine disk material under high frequency/low frequency loading cycles. The goal of the program is to provide a basis for damage-tolerant design of aircraft engine components under combined high and low frequency loading. Author (GRA)

N86-18319# Army Research and Technology Labs., Moffett Field, Calif.
AN INVESTIGATION OF THE USE OF BANDWIDTH CRITERIA FOR ROTORCRAFT HANDLING-QUALITIES SPECIFICATIONS
C. L. BLANKEN, C. C. BIVENS, and M. S. WHALLEY 1985 15 p Presented at the International Conference, Rotorcraft Basic Research, American Helicopter Society, Research Triangle Park, N.C., 19-21 Feb. 1985
(AD-A160664; NAS 1.26:176709; NASA-CR-176709) Avail: NTIS HC A02/MF A01 CSCL 01A

The objective of this study was to investigate bandwidth concepts for deriving rotorcraft handling-qualities criteria from data obtained in two simulator experiments conducted at the Aeromechanics Laboratory. The first experiment was an investigation of the effects of helicopter vertical-thrust-response characteristics on handling qualities; the second experiment investigated the effects of helicopter yaw-control-response characteristics. In both experiments, emphasis was on low-speed Nap-of-the-Earth (NOE) tasks. GRA

N86-18320# Aeronautical Research Labs., Melbourne (Australia).
THE TEST LOADS SEQUENCES APPLIED TO THE CT4 FULL SCALE FATIGUE TEST
L. R. GRATZER Jun. 1985 25 p
(AD-A160736; ARL-STRU-TM-415) Avail: NTIS HC A02/MF A01 CSCL 01A

This document presents an outline of the derivation of the test load sequences applied to the CTA full scale fatigue test. GRA

N86-18321# Aeronautical Research Labs., Melbourne (Australia).
RESONANCE FATIGUE TEST OF THE EMPENNAGE OF A CT4 AIRCRAFT
I. ANDERSON and L. MOLENT Jun. 1985 36 p
(AD-A160749; ARL/STRUC-TM-412) Avail: NTIS HC A03/MF A01 CSCL 01C

A resonance fatigue test was carried out on the rear fuselage and empennage of a CT4 aircraft. The structure was supported in a reaction frame, and was excited at the resonant frequency of the fuselage torsional mode (9 Hz) by electromagnetic shakers connected to the tailplane. The loading spectrum applied was based on strain sequence data obtained from flight trials. Regular inspections of the structure were carried out, and several areas on the rear fuselage and empennage were identified as being prone to fatigue damage. GRA

N86-18322# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
PRELIMINARY AIRWORTHINESS EVALUATION OF THE AH-1S (MODERNIZED COBRA) WITH THE HELLFIRE, TOW, AND STINGER MISSILES INSTALLED Final Report, 17 May - 27 Jul. 1984
R. MACMULLIN, G. T. DOWNS, E. TAVARES, J. S. LAWRENCE, and L. L. TODD Oct. 1984 188 p
(AD-A160862; USAAEFA-84-11) Avail: NTIS HC A09/MF A01 CSCL 01B

The aircraft was operated at gross weights up to 10,400 lb, up to 11,340 feet density altitude and at a lateral center of gravity (cg) range from one inch right to approximately three inches left. The asymmetric loadings were caused by the various combinations of armament configurations. The change in equivalent flat plate area compared to the clean aircraft for each configuration varied as a function of airspeed. At 130 knots true airspeed (KTAS), the increased flat plate area was 4.2 square feet for the Launcher configuration, 4.8 square feet for the TOW configuration, 6.6 square feet for the Hellfire and Hellfire/TOW configurations, and 7.8 square feet for the Stinger/Hellfire/TOW configuration. The increase in flat plate area for the Stinger/Hellfire/TOW configuration reduced maximum level flight speed for normal rated power by approximatley 8 KTAS. With the exception of the two armament related shortcomings listed below, the handling qualities and the reactions to system failures of the AH-1S (MC) were not significantly changed by the asymmetric loading of the various armament configurations. Four shortcomings were noted and follow in decreasing order of importance: (1) the high left rolling response to a sudden engine failure at power settings above 75% torque; (2) the undesirable maneuvering stability characteristics above 1.4 g's; (3) insufficient left pedal margin available in right sideward flight above 10 knots in the Hellfire and Hellfire/TOW configurations; and (4) insufficient left pedal margin available for ball-centered forward flight below 30 KCAS in the armament configurations with left lateral cf offset. A CAUTION is recommended for inclusion in the operator's manual. GRA

N86-18323# Joint Publications Research Service, Arlington, Va.
USSR REPORT: TRANSPORTATION
19 Dec. 1985 110 p Transl. into ENGLISH from various Russian articles
(JPRS-UTR-85-015) Avail: NTIS HC A06

Developments in transportation are reported from the Soviet Union. Among the topics discussed are: (1) civil aviation; (2) motor vehicles and highways; (3) rail systems; (4) maritime and river fleets; (5) ports and transshipment centers; (6) intersector network development; and (7) experimental systems.

N86-18324# Joint Publications Research Service, Arlington, Va.
SUKHOY DESIGN BUREAU BUILDS SPORT PLANE MADE OF PLASTIC
V. BELIKOV *In its* USSR Report: Transportation (JPRS-UTR-85-015) p 4-5 19 Dec. 1985 Transl. into ENGLISH from Izvestiya (Moscow, USSR), 16 Aug. 1985 p 3
Avail: NTIS HC A06

The design and construction of the Soviet Su-26 aircraft is discussed. The Su-26 is a sports aircraft which makes extensive use of plastic materials in its construction. G.L.C.

N86-18325# Joint Publications Research Service, Arlington, Va.
FEATURES OF PLANNED IL-96-300, IL-114 AIRCRAFT
G. V. NOVOZHILOV *In its* USSR Report: Transportation (JPRS-UTR-85-015) p 6-11 19 Dec. 1985 Transl. into ENGLISH from Pravda (Moscow, USSR), 27 Oct. 1985 p 6
Avail: NTIS HC A06

In accordance with the tradition, the general designer directly guides any new aircraft up to the conclusion of state testing, but this does not mean that he stops watching the aircraft closely during operation as well. Such an aircraft is now in the Experimental Design Bureau imeni S. Ilyushin--the Il-96-300 long-range mainline passenger aircraft. It is designed to carry 300 passengers, baggage, mail and freight on long-distance routes--up to 9,000 kilometers--with heavier passenger flows. Provision is being made for use of the aircraft on international routes, including those up to 11,000 kilometers in length. G.L.C.

N86-19312*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
GROUND VIBRATION TEST RESULTS FOR DRONES FOR AERODYNAMIC AND STRUCTURAL TESTING (DAST)/AEROELASTIC RESEARCH WING (ARW-1R) AIRCRAFT
T. H. COX and G. B. GILYARD Jan. 1986 36 p refs
(NASA-TM-85906; H-1261; NAS 1.15:85906) Avail: NTIS HC A03/MF A01 CSCL 01C

The drones for aerodynamic and structural testing (DAST) project was designed to control flutter actively at high subsonic speeds. Accurate knowledge of the structural model was critical for the successful design of the control system. A ground vibration test was conducted on the DAST vehicle to determine the structural model characteristics. This report presents and discusses the vibration and test equipment, the test setup and procedures, and the antisymmetric and symmetric mode shape results. The modal characteristics were subsequently used to update the structural model employed in the control law design process. Author

N86-19313*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DYNAMICS AND CONTROLS FLIGHT TESTING OF THE X-29A AIRPLANE
J. GERA Jan. 1986 13 p refs Presented at the 24th AIAA Aerospace Sciences Meeting, Reno, Nev., 6-9 Jan. 1986
(NASA-TM-86803; H-1333; NAS 1.15:86803; AIAA-86-0167)
Avail: NTIS HC A02/MF A01 CSCL 01C

A brief description of the flight control system of the X-29A forward-swept-wing flight demonstrator is followed by a discussion of the flight test techniques and procedures in the area of flight dynamics and control. These techniques, which evolved during the initial few months of flight testing, are based on integrating flight testing with simulation and analysis on a flight-by-flight basis. A limited amount of flight test results in dynamic stability and handling qualities is also presented. Author

N86-19314*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
HOVER AND FORWARD FLIGHT ACOUSTICS AND PERFORMANCE OF A SMALL-SCALE HELICOPTER ROTOR SYSTEM
C. KITAPLIOGLU and P. SHINODA 13 Sep. 1985 29 p Prepared in cooperation with Army Aviation Research and Development Command, Moffett Field, Calif., and City Univ., London, Engl.
(NASA-TM-88584; NAS 1.15:88584; AD-A160661) Avail: NTIS HC A03/MF A01 CSCL 20A

A 2.1-m diam., 1/6-scale model helicopter main rotor was tested in hover in the test section of the NASA Ames 40- by 80- Foot Wind Tunnel. Subsequently, it was tested in forward flight in the Ames 7- by 10-Foot Wind Tunnel. The primary objective of the tests was to obtain performance and noise data on a small-scale rotor at various thrust coefficients, tip Mach numbers, and, in the later case, various advance ratios, for comparisons with similar existing data on full-scale helicopter rotors. This comparison yielded a preliminary evaluation of the scaling of helicopter rotor performance and acoustic radiation in hover and in forward flight. Correlation between model-scale and full-scale performance and acoustics was quite good in hover. In forward flight, however, there were significant differences in both performance and acoustic characteristics. A secondary objective was to contribute to a data base that will permit the estimation of facility effects on acoustic testing. GRA

N86-19315# JAI Associates, Mountain View, Calif.
AERODYNAMICS OF TWO-DIMENSIONAL BLADE-VORTEX INTERACTION
G. R. SRINIVASAN, W. J. MCCROSKEY, and J. D. BAEDER 1985 20 p Previously announced in IAA as A85-40685
(Contract DAAG29-85-C-0002)
(AD-A160662) Avail: NTIS HC A02/MF A01 CSCL 01C

A computational procedure and some numerical results of unsteady interaction of a helicopter rotor blade with a Lamb-like vortex of finite viscous core in subsonic and transonic flows is presented. The interaction considered here is one of the limiting cases of a more complex interaction typically encountered on helicopter rotor blade. In this limit, the interacting flow field is considered to be unsteady but two-dimensional. Accordingly, unsteady, two-dimensional, thin-layer Navier-Stokes equations are solved using a prescribed-vortex method (also called perturbation method) for the cases of stationary and moving rotor blades encountering a moving vortex passing the blades. The numerical results are compared with the recent experimental data of Caradonna et al. for the latter case. The comparison shows that for the transonic cases, the flow field is dominated by the presence of the shock waves, with strong indications of unsteady time lags in the shock-wave motions and shock-wave strengths, and of important three-dimensional effects. For subcritical-flow cases, however, the unsteady lag effects on the basic rotor blade are absent, and three-dimensional effects appear to be negligible, unlike the supercritical case. The subcritical calculations are in good agreement with the experimental data. GRA

N86-19316# Army Aviation Systems Command, St. Louis, Mo.
CORRELATION OF RESULTS OF AN OH-58A HELICOPTER COMPOSITE TAIL BOOM TEST WITH A FINITE ELEMENT MODEL
N. CALAPODAS and K. HOFF Sep. 1985 32 p
(Contract DA PROJ. 1L1-62209-AH-76)
(AD-A161062; USAAVSCOM-TR-85-D-15) Avail: NTIS HC A03/MF A01 CSCL 01C

The results of testing an OH-58A composite tail boom and comparing its static and dynamic characteristics with those obtained from finite element analyses are presented in this report. Static load versus deflection data were used to verify the stiffness representation of the finite element model. Ground vibration test data were used to evaluate frequency and modal responses obtained from analysis. Discussions of each test configuration, including data analysis methodology and correlation results, are presented. Differences between measured static deflections and finite element analysis calculated deflections range from 6 to 12 percent. Natural frequency differences between test and analysis were less than 5 percent for the first and second elastic modes. Problems encountered during the testing and the impact on correlation are also discussed. GRA

N86-19318# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
FLIGHT TEST EVALUATION OF THE NETHERLANDS FLIGHT INSPECTION AIRCRAFT
D. GEELS 14 May 1984 43 p refs Presented at 3rd International Flight Inspection Meeting, Ottawa, Ontario 28 May-1 Jun. 1984
(NLR-MP-84052-U; B8571448) Avail: NTIS HC A03/MF A01

Flight test evaluation of a flight inspection aircraft (Cessna Citation 500) equipped with position sensors, calibrated navaids receivers and a fully automatic data acquisition and data processing system for the real-time calibration and inspection of radionavigation and instrument landing systems was carried out. For the evaluation and acceptance of the en-route part of the system, a small, light-weight flexible data acquisition system was installed. Using a specially developed software package, high accuracy position reference data was computed off-line to demonstrate the CFIS navaids en route calibration performance and to determine the overall navigation accuracy of the flight inspection and navigation system during the calibration flights. The distance measuring equipment position reference method, the function and the operational principle of the flight inspection system, additional test equipment, and the data processing are described. Author (ESA)

N86-19319# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
DETERMINATION OF LIMITATIONS FOR HELICOPTER SHIP-BORNE OPERATIONS
C. F. G. M. HOFMAN and R. FANG 15 Aug. 1984 14 p Presented at 10th European Rotorcraft Forum, The Hague, Netherlands, 28-31 Aug. 1984 and RINA International Symposium on Air Threat at Sea, London, England, 11-14 Jun. 1985
(NLR-MP-84072-U; B8572249) Avail: NTIS HC A02/MF A01

The organization of helicopter-ship qualification trials based on experience with trials with various helicopter types on different classes of ships is discussed. Procedures applied are described and illustrated. Author (ESA)

N86-19836# Joint Publications Research Service, Arlington, Va.
IMPROVING COMMERCIAL AIRCRAFT TRAINING SIMULATORS
V. GORYACHEV *In its* USSR Report: Life Sciences. Biomedical and Behavioral Sciences (JPRS-UBB-86-001) p 48-49 2 Jan. 1986 Transl. into ENGLISH from Vozdushnyy Transport (Moscow, USSR), 10 Sep. 1985 p 3
Avail: NTIS HC A06

Studies of the use of technical means of instruction was begun in 1976. Results of this research indicated that training with simulators could take the place of flight training of crews in

preparation for spring and summer flight operations. Instructions from the Ministry of Civil Aviation to this effect were issued in 1977. This change has proved effective. Effective use of comprehensive training simulators has become an important way of saving fuel. Flight training in flight schools still takes up a large portion of their time, the benefit yielded by helicopter training simulators still is not large enough, and possibilities exist for reducing unproductive flight time in a whole series of training programs for flight crews. Author

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A86-22720

ADVANCED MEDIUM SCALE REAL-TIME SYSTEM

A. L. KELLEY (Fairchild Weston Systems, Inc., Data Systems Div., Sarasota, FL) IN: European Telemetry Conference, 7th, Boeblingen, West Germany, May 21-24, 1984, Reports. Part 2 . Wessling, West Germany, Arbeitskreis Telemetrie, 1984, p. 7.1-7.1.16.

In 1960, the U.S. Army Aviation Engineering Flight Activity (USAAEFA) was formed to perform flight test evaluations of Army aircraft. In 1977, the USAAEFA initiated an investigation regarding the feasiblity of replacing the previous system because of age and lack of growth potential. With respect to the selection of a replacement system, an architecture was to be chosen which would not utilize hardware or software capabilities considered to be 'pushing the state-of-the-art'. Attention is given to the definition of an optimum system, questions of engineering interaction, the man-machine interface, a system description, the telemetry acquisition subsystem, the preprocessing system, the computer system, the operating system, the setup and application software, and a data flow overview. G.R.

A86-22728

THE DATA TRANSMISSION AND PROCESSING EQUIPMENT OF A HIGH-PRECISION TRAJECTORY MEASUREMENT SYSTEM [DIE DATENUEBERTRAGUNGS- UND -VERARBEITUNGSEINRICHTUNGEN EINES HOCHPRAEZISEN FLUGBAHNVERMESSUNGSSYSTEMS]

P. SCHULZ (DFVLR, Institut fuer Flugfuehrung, Brunswick, West Germany) IN: European Telemetry Conference, 7th, Boeblingen, West Germany, May 21-24, 1984, Reports. Part 2 . Wessling, West Germany, Arbeitskreis Telemetrie, 1984, p. 8.11-8.11.11. In German.

A measurement system has been designed for the study of approach and landing systems. The aircraft employed for the experiments contains an onboard device of the system to be tested and, in addition, equipment of the measurement system. In ground tests, the aircraft is replaced by a ground test vehicle. On the ground at the airport, the ground stations of the landing system to be studied together with stations of the measurement system are located at suitably selected positions. A suitable system for data processing operations is needed for the conduction of the required flight and ground tests. This data system has to perform functions related to data acquisition and transmission, data processing and storage, and data display. Details regarding the conduction of the required operations are discussed. G.R.

A86-23255

ENGINE/AIRFRAME HEALTH AND USAGE MONITORING AN ALTERNATE APPROACH VIA ADVANCED VIBRATION MONITORING SYSTEMS

M. D. FLOYD (Vibro-Meter, S.A., Fribourg, Switzerland) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 4-1 to 4-11.

The paper describes the latest developments in advanced vibration monitoring systems and their logical extension to provide an integrated engine/airframe health and usage monitoring package. Such systems require close cooperation between supplier and engine/airframe manufacturer during development, flight test and service operation in order to establish the data base used to make the system intelligent. Author

A86-23272

INFLIGHT RESOLUTION EVALUATION FOR THERMAL IMAGING SYSTEMS

S. E. SHIMER (USAF, Flight Test Center, Edwards AFB, CA) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 21-1 to 21-5.

This paper presents a method to determine the resolution of an airborne Thermal Imaging System (TIS) under the conditions and in the environment of typical operation. By determining the resolution of the entire system (e.g., sensor, aircraft, display, pilot) a more realistic measure of the system's true resolution can be determined. The effects of Atmospheric Transmission and Target Radiation are also included in the evaluation. Author

A86-23275

AIR FORCE FLIGHT TEST INSTRUMENTATION SYSTEM - AN INTRODUCTION FOR FLIGHT TEST ENGINEERS AND MANAGERS

J. M. POSNER and R. A. KITCHEN (USAF, Flight Test Center, Edwards AFB, CA) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 24-1 to 24-11.

The design and development of the Air Force Flight Test Instrumentation System (AFFTIS) are described. The proposed design of the AFFTIS is a digital modular system with remote sensing multiplex capability and is based on the use of data acquisition units (DAUs). The hardware for the AFFTIS, which includes an AFFTIS system controller, a data bus, a system power supply, DAUs, cockpit data displays, and the Analog-Discrete Data Acquisition Unit, are examined. The Laboratory Support System, Ground Support Unit, and Remote Site Unit are applied to hardware unit testing, software programming for the test configuration formats, and on-aircraft checks of the installed instrumentation hardware. The organizational, intermediate, and depot level maintenances, and the role of the system manager are analyzed. The economical advantages the AFFTIS provides are studied. I.F.

A86-23293

AIRBORNE RADAR. I - AIR-TO-SURFACE

J. CLARKE (Royal Signals and Radar Establishment, Malvern, England) and C. M. STEWART (Ferranti, PLC, Edinburgh, Scotland) Microwave Journal (ISSN 0026-2897), vol. 29, Jan. 1986, p. 32, 34, 36 (5 ff.).

Airborne radar has retained its attraction as a sensor, despite the development of alternative technologies. The reasons for this situation are related to the flexibility of radar in adapting to a wide range of operations roles, a relative immunity to weather conditions, and an ability to detect relatively small targets at considerable distances. Recent developments are related to the innovation of powerful, high speed computers suitable for airborne use, and the adoption of coherent radar systems relying on the use of an RF power amplifying tube rather than the self-oscillating magnetron. This paper provides a review of the various classes of airborne radars in the light of the introduction of new capabilities. Attention

is given to air-to-surface roles, sea surface reconnaissance, land reconnaissance, close air support and strike, and terrain clearance. G.R.

A86-23313
A VME BUS MICROCOMPUTER SYSTEM FOR EXPERIMENT CONTROL AND ANALYSIS ON BOARD AN AIRCRAFT
A. J. DEMPSTER (Wellington, Victoria University, New Zealand) New Zealand Journal of Technology (ISSN 0112-3890), vol. 1, April 1985, p. 53-60. Research supported by the New Zealand Meteorological Service. refs

The severe mechanical environment on board an aircraft requires that special consideration be given to the selection of equipment for experiment control and analysis. In the system described in this paper, the VME bus and Motorola 68000 were chosen. These combine a modern state-of-the-art 16-bit microprocessor with a secure mounting system and a wide range of experiment interfaces configured from standard Eurobus boards. A real-time operating system and applications software were written in the high-level language 'C'. This provides sufficient structure facilities with enough access to machine-level components. With certain safeguards it was possible to place all object code in ROM. All software was developed on a host computer using cross-compiler and cross-assembler. The approach taken was dictated mainly by cost but has met the initial requirements of real-time experiment control and data analysis. Author

A86-23728* Michigan Univ., Ann Arbor.
THE UTILITY OF HEAD-UP DISPLAYS - EYE-FOCUS VS DECISION TIMES
D. J. WEINTRAUB (Michigan, University, Ann Arbor), R. F. HAINES, and R. J. RANDLE (NASA, Ames Research Center, Moffett Field, CA) IN: Human Factors Society, Annual Meeting, 28th, San Antonio, TX, October 22-26, 1984, Proceedings. Volume 1 . Santa Monica, CA, Human Factors Society, 1984, p. 529-533.

Instrument-panel information is presented by a Head-Up Display (HUD) to pilots in such a way that the symbols appear far away (at optical infinity) superimposed upon the landscape. The use of a HUD makes it, therefore, unnecessary for the pilot to take his eyes off the changing scene in order to look down and refocus on the instrument panel. It is pointed out that the HUD has proved superior to the conventional instrument-panel display. An experiment was conducted with the objective to help to determine which of the differences between HUD and conventional instrument-panel display are mainly responsible for the superiority of the HUD. Important features of this experiment are that the format of each virtual-image display, its luminance, and its angle subtended at the eye, remained the same as the optical distance and location were varied. It was found that the HUD symbology at optical infinity does reduce decision times compared to the same format at the location of a conventional instrument panel. G.R.

A86-23729
A PRELIMINARY FLIGHT EVALUATION OF THE PERIPHERAL VISION DISPLAY USING THE NT-33A AIRCRAFT
V. GAWRON and L. KNOTTS (Calspan Advanced Technology Center, Buffalo, NY) IN: Human Factors Society, Annual Meeting, 28th, San Antonio, TX, October 22-26, 1984, Proceedings. Volume 1 . Santa Monica, CA, Human Factors Society, 1984, p. 539-541. Research supported by the Department of National Defence of Canada.
(Contract F33615-79-C-3618)

The Malcolm Horizon, a Peripheral Vision Display (PVD), was installed in the NT-33A variable stability research aircraft to provide the evaluation pilot with a gyrostabilized horizon line of red laser light. An experiment was conducted to determine the effect of the PVD on pilot workload. Workload was inferred from performance on a secondary task, in this case the Sternberg task, generated by the Workload Assessment Device (WAD). The primary task required the pilot to maintain airspeed, altitude, and angle of bank during instrument flight conditions. Nine NT-33A flights were flown by two evaluation pilots. Presence of the PVD reduced the WAD reaction times of one of the pilots; the reaction times of the other pilot showed mixed results. Recommendations for future research are presented. Author

A86-23762
AIRBORNE DIAGNOSTIC EQUIPMENT [TECHNICKE PROSTREDKY PALUBNI DIAGNOSTIKY]
K. HORAK Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1985, p. 237-242. In Czech.

The paper presents the general design and brief descriptions of the main components of an airborne recording system for maintaining records of routine flight and emergency data. The main technical and performance characteristics of the system are presented. The information presented here may be useful in considering some other applications for the recording system. V.L.

A86-23763
THE MEASURING AND CONTROL UNITS OF AIRBORNE RECORDING SYSTEMS [MERICI A RIDICI JEDNOTKY PALUBNICH REGISTRACNICH ZARIZENI]
J. BENDA and J. VIDIECAN Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1985, p. 243-247. In Czech.

The general design and the main components of the equipment used for monitoring and processing of the parameters of the aircraft powerplant and other airborne systems are discussed. The principal factors affecting the design of the monitoring and control equipment are then examined, and current trends in the modernization of the airborne data acquisition systems are reviewed in relation to the available commercial hardware and special operating conditions. V.L.

A86-23765
THE POSSIBILITY OF USING THE ON-BOARD COMPUTER FOR IN-FLIGHT DIAGNOSTICS [MOZNOSTI VYUZITI PALUBNIHO VYPOCETNIHO SYSTEMU PRO DIAGNOSTIKU V PRUBEHU LETU]
M. KNEZOVIC Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1985, p. 253-257. In Czech. refs

The possibility of using the on-board digital computer for monitoring the condition of the aircraft and its components during the flight is examined. It is suggested that, in addition to routine flight data processing, such a system can monitor in real time the parameters characterizing the technical conditions of the aircraft and its systems, analyze this information, and issue a timely warning of the impending danger. V.L.

A86-24583
SENSOR SYSTEM CONCEPT FOR FUTURE FIGHTER AND STRIKE AIRCRAFT [KONZEPT EINES SENSORSYSTEMS FUER ZUKUENFTIGE JAGD- UND KAMPFFLUGZEUGE]
B. STIELER (DFVLR, Institut fuer Flugfuehrung, Brunswick, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 9, Nov.-Dec. 1985, p. 339-348. In German. refs

Laser gyro multifunction inertial sensor assemblies (MISA) can be used for navigation, flight control, cockpit instrumentation, and computation of weapon delivery in future fighter and strike aircraft and will contribute to a reduction of an aircraft's life cycle costs. The internal MISA signal processing, which is adapted to increased laser gyro noise, is discussed. The potential for increased MISA navigational accuracy through the use of external sensors is considered, especially for automated terrain-following flight. The increased reliability required in sensor systems of control-configured vehicles will be attained by highly reliable sensors and a skewed montage, as in two MISAs. A special signal processing permits detection and identification of sensor or subsystem failure and the reconfiguration of the remaining system. The failure probability of various system configurations is calculated. C.D.

A86-24827
DESIGN OF THE F-16 AIRCRAFT ELECTRICAL SYSTEM BUILT-IN-TEST MONITOR
M. A. ROSSWURM (Cummins Engine Co., Columbus, OH) and L. L. TIPTON (Westinghouse Electric Corp., Electrical Systems Div., Hunt Valley, MD) IN: Intersociety Energy Conversion Engineering Conference, 20th, Miami Beach, FL, August 18-23, 1985, Proceedings. Volume 1 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 1.367-1.373.

Built-In-Test (BIT) capability in aircraft electronic equipment has the potential to reduce maintenance effort and increase aircraft availability. This paper describes a BIT monitoring scheme used on a high performance fighter aircraft to detect and isolate faults in the electrical generation equipment. An overview of the BIT monitor is given, along with a detailed analysis of a typical subsystem BIT equation. The results and method of test for a hardware BIT demonstration are detailed. Some ideas and an example of improving the display of maintenance information by the use of graphic display devices are presented. Finally, some techniques are explored for simplifying the detection and isolation of electrical system faults through the use of remote diagnostic tools. Author

A86-26006
THE HUD AS A PRIMARY FLIGHT INSTRUMENT
P. B. LOVERING and . S. ANDES (Midwest Systems Research, Inc., Dayton, OH) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 33-36.
(SAE PAPER 841463)

The usefulness of head-up displays (HUDs) in the modern fighter aircraft is often impaired by the fact that the functions of HUD are not always intuitively obvious, and the HUD descriptions are sometimes confusing or incomplete. The aspects of current display symbology, mechanization schemes, needs, and some possible modifications are discussed. Use of identical terms to describe two different functions, variation in information content across the various HUDs, and use of multiple display formats in altitude and navigation displays are given as examples of inadequacies that diminish the HUD usefulness. The short-term steps suggested for improving the utility of existing HUDs include standardization of all symbols and fundamental display concepts. The long-term steps involve redesigning the HUD systems to make the displays easier to interpret and to use. I.S.

A86-26007
PRESENTATION OF RADAR ALTITUDE INFORMATION ON THE HUD
L. A. CARR (USAF, Washington, DC) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 37-43. refs
(SAE PAPER 841464)

Radar altimeters are being included in several existing Air Force aircraft. Of these, the A-10, F-15, and the F-16 are also envisioned to perform the night, under the weather attack mission. This mission, coupled with limited available cockpit space and the anticipated high pilot workload has led to a design effort to include the radar altimeter on the HUD. The LANTIRN system offered a key opportunity to accomplish this HUD integration. The design has evolved from pilot opinions through simulation and now flight test. Plans are currently being made to conduct a simulation to make minor changes to the display based on test results to further optimize the display. This radar altimeter design and particularly the way the design has evolved should serve as examples for future efforts. Of particular note is that this display has been designed from the beginning for a specific purpose and is being optimized for its intended operational environment and the pilots who will use it. Author

A86-26008
FLIGHT DECK DISPLAYS FOR MANAGING WIND SHEAR ENCOUNTERS
R. G. JOPPA and R. K. NICHOLSON (Washington, University, Seattle) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 45-51.
(SAE PAPER 841465)

A concept of a flight energy instrument system is presented in which the rate of energy with respect to air is used to give the pilot a predictive indication of changes in descent rate due to the wind shear during the approach to landing. Rate of change of total energy is measured and compared to vertical speed, the difference being the change of vertical speed if the shear continues. Flight path angles are displayed on an electronic attitude indicator. In addition, a novel airspeed instrument is described which has two needles, one being the regular pointer to show the airspeed, and the other showing the sum of the airspeed plus the rate of change in the airspeed. The needle separation is a measure of the wind shear rate. Separation of turbulence from shear is accomplished by filtering. The two concepts may be implemented with commercially available hardware or by simple computations using an on-board air data system. I.S.

A86-26010
ELECTRONIC DISPLAY OF POWERPLANT PARAMETERS
D. K. GRAHAM (Boeing Co., Seattle, WA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 61-67.
(SAE PAPER 841467)

Results of simulator testing of the seven-color CRT displays in the 757/767 Engine Indication and Crew Alert System are discussed. As a result of this evaluation, changes were made in the displays, such as removal of green bands from all gages, introduction of 'boxed' readouts, and format changes. In addition, results from simulator tests of the digital-only testing, done in support of the Standby Engine Indicator are presented. It was concluded that, while the digital-only displays appear to be not as good as the analog-plus-digital displays, their performance is acceptable, and they may have more operational utility than is commonly realized. I.S.

A86-26012
PRESENTATION OF INFORMATION ON MULTIMODE DISPLAYS - ABNORMAL AND EMERGENCY AIRCRAFT OPERATIONS
G. R. GERSHZOHN (Rockwell International Corp., Pittsburgh, PA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 75-83.
(SAE PAPER 841494)

The capability of a multimode display system to present data regarding malfunctioning aircraft systems is illustrated. The development of formats for abnormal operations is based on the correspondence between cognitive requirements of the pilot and displayed information. Three different stages of cognitive processing are identified and associated formats are developed. System architecture provides for the display of required information tailored to pilot requirements in identifying, understanding, and solving malfunctions via a simple multimode display interface. Author

A86-26032
COCKPIT ADVANCES IN BOEING VERTOL COMPANY'S MODEL 360 HELICOPTER
A. T. SHERBERT (Boeing Vertol Co., Philadelphia, PA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 237-241.
(SAE PAPER 841629)

The cockpit advances incorporated into the design of an advanced-composite Model 360 technology demonstration

helicopter are described. Perhaps the most important feature of the helicopter will be its lighting system, which has been designed to accommodate both the sunlight readable and night vision goggle-compatible modes of operation. An advanced flight control system features an integrated system of six CRT displays and two data entry keyboards, and a multiplexing control display system to interface them and their supporting subsystems. In addition, the head clearance envelope was redesigned to minimize vehicle contour in the cockpit area; the cockpit area was designed to accommodate the 2nd through 98th percentile aviator with a wide range of anthropometric requirements, and the envelope of vision has been improved. I.S.

A86-26129#
CRT DISPLAYS IN MODERN HELICOPTER DATA PRESENTATION
M. R. DUELL (Westland Helicopters, Ltd., Yeovil, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 23 p.

The use of CRT displays as Electronic Flight Instruments (EFIS) for helicopters, and their adoption for the cockpit designs of Westland's 30-300 and EH101, are discussed. The multicolored, multifunctional CRT display resulting in more efficient use of the instrument panel area, in addition to its capability of displaying Torque and Tacho, Hover, and search pattern information, contributes to a reduction in pilot workload and cost. However, the weight penalty and higher initial cost of the CRT displays can be minimized by the multiple use of displays via careful format definition. Certification of EFIS for civil helicopters requires comparable reliability to the electromechanical instruments it replaces, and a high level of system redundancy. EH101 display function requirements determined the choice of shadowmask CRT displays. The Westland 30-300 will incorporate EFIS into a system with interfaces between avionics and flight instrumentation already defined with possible adaptation. R.R.

A86-26130#
VISUALLY COUPLED EO SYSTEM DEVELOPED FOR THE RAE SEA KING XV371
I. MANSFELD (Royal Aircraft Establishment, Flight Systems Dept., Farnborough, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 17 p.

This paper describes the development of a visually coupled system (VCS) and its assessment as a piloting and navigational aid for low level night operations. The overall aim is to define the requirements for each component of a VCS. The trials have been carried out using a Sea King helicopter as the trials vehicle, fitted with a rapid acting two degree of freedom platform capable of matching the head motion rates of the pilot. The sensor used on this platform is an Isocon low light TV camera, though an infrared sensor has been fitted for the next stage of trials. Two types of head position tracker have been used, one electromagnetic in principle and the other utilizing infrared light. Flight symbology has been superimposed onto the sensor image and presented to the pilot on a monocular helmet mounted display comprising a miniature CRT and optics. The results of the trials and their implications on the system components are described. The current trials equipment and plans for the next stage of investigations are discussed. Author

A86-26132#
SAFETY ASPECTS IN STORES MANAGEMENT SYSTEMS
F. CRISPOLTI and G. SCOTTI DI UCCIO (Selenia - Industrie Elettroniche Associate S.p.A., Pomezia, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 18 p.

The system architecture of Stores Management Systems (SMS) in combat aircraft and rotorcraft is examined and related to safety and mission success. A general purpose SMS is outlined, and the main reliability parameters are defined. Mono channel systems, multichannel reconfigurable systems, and communication channels are presented and discussed. C.D.

A86-26153#
THE HEALTH AND USAGE MONITORING SYSTEM OF THE WESTLAND 30 SERIES 300 HELICOPTER
D. G. ASTRIDGE and J. D. ROE (Westland, PLC, Helicopter and Hovercraft Group, Yeovil, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 19 p. refs

The design philosophy behind the health and usage monitoring developments on the Westland 30 series of helicopters is discussed including their relevance to the recently published review of helicopter airworthiness (HARP report). The necessity for a comprehensive on-board data processing system such as that described in this paper becomes patently obvious. The functions included in the system related to engines, the transmission, and rotor systems. Experience has been gained with the implementation of many of these functions separately on development and production aircraft. Details are given of the processor, its interfaces, data links, sensors, and data retrieval unit, together with an overview of the development program. Author

N86-19321# New Mexico State Univ., Las Cruces. Behavioral Engineering Lab.
HORIZONTAL DISPLAY FOR VERTICAL FLIGHT: A DIRECTION OF MOTION EXPERIMENT
E. J. TRUJILLO and S. N. ROSCOE May 1985 48 p
(Contract N00014-81-K-0439)
(AD-A161113; BEL-85-1/ONR-85-1) Avail: NTIS HC A03/MF A01 CSCL 01D

As a part of a research program to investigate advanced concepts for downward and forward-looking integrated displays, an experiment was conducted to determine optimum direction-of-motion relationships for a new way of presenting altitude and vertical rate information superposed on a downward-looking navigation and tactical situation display. Altitude was represented by the size of an octagon that could either dilate or constrict to indicate increasing altitude, and vertical rate was indicated by the outward or inward flow of four rate-field patterns emanating from the center of the display toward the 45, 135, 225, and 315-degree compass positions. The five factors in this experiment were altimeter and vertical rate-field direction of motion, subject ability level, aircraft vertical control order, and vertical flight course. Performance on four vertical flight profiles indicated that the out is up relationship yields superior vertical control, both in terms of control reversals and log RMS tracking precision, whereas the out is down mode results in more accurate control in the horizontal plane. GRA

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A86-23273
A FLIGHT EVALUATION OF A DIGITAL ELECTRONIC ENGINE CONTROL
A. T. WEBB and D. L. CORSENTINO (USAF, Flight Test Center, Edwards AFB, CA) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 22-1 to 22-7.

A production F100-PW-200 engine incorporating a digital electronic engine control (DEEC) was installed in an F-16 aircraft

and evaluated throughout the flight envelope. Aspects of engine operation evaluated included afterburner and dry power throttle transients, airstarts, secondary control mode operation, and maneuvering flight. The F100 DEEC was found to be a significant improvement over the production F100-PW-200. The afterburner envelope was expanded and blowouts and compressor stalls were eliminated. Dry power operation and engine response were comparable to the production engine. Airstart capability was enhanced by an expansion of the airstart envelope of 20 to 25 percent in airspeed. Secondary control mode airstart capability was similar to that in the production engine. Similarity in airstart procedures between primary and secondary mode was a major advantage. Secondary mode engine operation was generally satisfactory. Author

A86-23350#
AIRCRAFT FUEL PUMP DESIGN
U. S. ROHATGI (Brookhaven National Laboratory, Upton, NY) IN: Design methods for two-phase flow in turbomachinery; Proceedings of the Mechanics Conference, Albuquerque, NM, June 24-26, 1985. New York, American Society of Mechanical Engineers (Fluid Engineering Symposia Series. FED Volume 26), 1985, p. 1-5. refs

A need to pump a mixture of two-phase fluid appears naturally in many situations. One example of this situation is aircraft fuel systems, where the pump inlet may have two-phase mixture due to the desorption of the dissolved gases at low pressures at higher altitudes. A procedure of selecting proper design conditions for the inlet inducer and a method of sizing the inducer, impeller and volute to meet all the design requirements has been described. This procedure has also been applied to a typical fighter plane boost pump design. Author

A86-23506
DIGITAL CONTROL FOR ENGINE BLEED AIR
D. J. WIEMER (Sundstrand Aviation Mechanical, Rockford, IL) AIAA, SAE, ASME, AIChE, and ASMA, Intersociety Conference on Environmental Systems, 15th, San Francisco, CA, July 15-17, 1985. 11 p.
(SAE PAPER 851316)

As modern control systems become more demanding and complex and the optimum control algorithm becomes more elusive, it becomes obvious that the versatility of control algorithm construction and modification in software is far superior to analog circuit implementations. A digital microprocessor based electronic control system has been developed for temperature control of engine bleed air on the B-1B bomber. The Engine Bleed Air Control System (EBACS) provides pressurized, temperature controlled air to various subsystems on the aircraft. This paper addresses the unique approach used in controlling a bleed air system having major gain variations (over 500 to 1) and major system-element time-constant variations (over 5 to 1) within the flight envelope, while still maintaining specified response times and stablity margins. Author

A86-23664
THE EFFECT OF THE VELOCITY PROFILE AT THE DIFFUSER INLET ON THE FLOW PATTERN [VLIIANIE PROFILIA SKOROSTI NA VKHODE V DIFFUZOR NA KARTINU TECHENIIA]
A. M. TURILOV and G. M. SHALAEV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 3, 1985, p. 70-74. In Russian. refs

Results of an experimental study of flow structure in the diffuser of a gas-turbine engine are presented for various types of nonuniform velocity profiles at the diffuser inlet. The changes in the mean and maximum jet characteristics along the diffuser length are examined. Results are presented in graphic form. V.L.

A86-23670
EMISSION CHARACTERISTICS OF A SECTION OF THE COMBUSTION CHAMBER OF A GAS-TURBINE ENGINE WITH VARIOUS MODIFICATIONS OF THE BURNERS [EMISSIONNYE KHARAKTERISTIKI OTSEKA KAMERY SGORANIIA GTD S RAZLICHNYMI MODIFIKATSIIAMI GORELOCHNYKH USTROISTV]
F. M. VALIEV, A. V. TALANTOV, and V. A. SHCHUKIN Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 3, 1985, p. 91, 92. In Russian.

The paper reports the results of an experimental study of the emission characteristics of a 9-burner section of the combustion chamber of a gas-turbine engine. Results are reported for experimental and standard burners which differ in the method of air-fuel mixture preparation. It is shown that the use of experimental burners producing a mixture of prevaporized fuel partially mixed with air that is fed together with secondary air results in a decrease in HC and CO emission over the full range of stable combustion, with a certain increase in NO(x). In the case of lean mixtures, the use of the experimental burners improves the emission characteristics for all toxic gases. V.L.

A86-23751
DIAGNOSTIC METHODS FOR GAS-TURBINE AIRCRAFT POWERPLANTS [DIAGNOSTICKE METODY LETECKYCH TURBINOVYCH JEDNOTEK]
S. SOUKUP Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1985, p. 147-149. In Czech.

The potential of advanced in situ diagnostic techniques for increasing the reliability of gas-turbine aircraft powerplants is examined. The currently used diagnostic techniques are reviewed, with particular attention given to the continuous monitoring and recording of the operating parameters of the powerplant in flight. The prospects for adopting this approach for local commercial airlines is discussed. V.L.

A86-23752
DETERMINATION OF DIAGNOSTIC PARAMETERS FOR THE IN SITU DIAGNOSTICS OF THE AIR-GAS PATH OF THE AI-25TL ENGINE [STANOVENIE DIAGNOSTICKYCH PARAMETROV PRE BEZDEMONTAZNU DIAGNOSTIKU VZDUCHO-PLYNOVEHO TRAKTU MOTORA AI 25 TL]
J. DULENCIN Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1985, p. 151-156. In Slovak. refs

An approach is proposed for selecting diagnostic parameters for the in situ diagnostics of the air-gas path of the AI25TL jet engine. Use is made of tables of coefficients describing the effect of independent parameters on the dependent characteristics; also, a procedure for diagnosing the engine condition on the basis of the measured independent parameters is detailed. Finally, tables are presented for verifying the calculated coefficients against the measured parameters and simulated faults. V.L.

A86-23753
SOUND GENERATION BY AN ENERGETICALLY INHOMOGENEOUS GAS FLOW IN A GAS-TURBINE AIRCRAFT ENGINE [GENERACE ZVUKU ENERGETICKY NEHOMOGENNIM PROUDEM PLYNU, KTERY PROTEKA TRAKTEM LETECKEHO TURBINOVEHO MOTORU]
F. KOPECKY Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1985, p. 157-160. In Czech. refs

Mathematical models describing sound generation by an energetically inhomogeneous air flow issuing from a model of a gas-turbine aircraft engine into a quiescent ambient medium are examined. An aerodynamic installation is then briefly described which has been built for the experimental determination of the relationship between the degree of flow inhomogeneity and the parameters of the generated sound. V.L.

A86-23754
SIMULATION OF THE VIBRATION TRANSMISSION PATH AND THE USE OF A MATHEMATICAL MODEL OF VIBRATION TRANSMISSION FOR THE VIBRATIONAL DIAGNOSTICS OF AN AIRCRAFT ENGINE [MODELOVANI PRENOSOVE CESTY VIBRACI A VYUZITI MATEMATICKEHO MODELU PRENOSU VIBRACI PRO VIBRODIAGNOSTIKU LETECKEHO MOTORU]
D. KRENEK Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1985, p. 161-164. In Czech. refs

A simplified model describing vibration transmission in a gas-turbine aircraft engine is presented which is based on the method of the initial flexural vibrations and on solving the motion transmission problem through an expansion in natural vibration modes. A software implementation of the vibration transmission model is briefly described, and some results are presented in the form of diagrams. V.L.

A86-23756
A HOLOGRAPHIC STUDY OF THE VIBRATIONAL MODES OF AIRCRAFT ENGINE ROTORS [HOLOGRAFICKE VYSETROVANI TVARU KMITANI OBEZNYCH KOL LETECKYCH MOTORU]
K. ANTROPIUS and A. PASLEROVA Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1985, p. 173-177. In Czech. refs

The use of holographic interferometry for investigating the vibrational modes of aircraft engine components in general and rotors in particular is reported. Methods using time-averaged and additional exposures are briefly described; attention is also given to surface preparation procedures prior to holographic measurements and methods of resonance excitation. Sample interferograms of rotors and blades are presented. V.L.

A86-23832#
AN EXPERIMENTAL INVESTIGATION OF RESPONSE OF A TURBOJET ENGINE TO INLET DISTORTION
F. CHEN, W. LI, Z. WANG, and M. CONG (Northwestern Polytechnical University, Xian, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 5 p. refs
(ASME PAPER 85-IGT-12)

A study of the response of a turbojet engine to the steady-state and the turbulence-type dynamic inlet distortion is presented. The steady-state distortion is generated by a 180 deg extent, 36 mesh screen, and the turbulence-type dynamic distortion by a 180 deg extent plate with 50 percent blockage ratio at the engine face. This plate can produce a very strong pressure fluctuation at the engine face. Results from testing show: (1) inlet distortion generated by the screen will produce a classical-surge or deep-surge; (2) the degree of distortion by the screen can change the mode of surge, e.g. from the classical surge to the deep surge and vice versa; (3) both the inlet distortion and the decrease in first-stage-turbine-nozzle area will change the compressor performance maps; (4) the turbulence-type dynamic distortion causes a 'drift-surge'. Author

A86-23853#
A COST-EFFECTIVE PERFORMANCE DEVELOPMENT OF THE PT6A-65 TURBOPROP COMPRESSOR
T. YOSHINAKA and K. S. THUE (Pratt and Whitney Canada, Aerodynamics Dept., Longueil) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 9 p. refs
(ASME PAPER 85-IGT-41)

The largest member of the PT6 turboprop engine family, the PT6A-65, was developed in the early 1980's and went into production in September 1982. The compressor for this engine consisted of four new axial stages combined with an existing centrifugal stage on a single shaft. This paper gives a brief description of the studies leading up to the choice of the compressor configuration and a more detailed examination of the development of the chosen compressor to the required performance level. The development of this compressor presented a two-fold technical challenge. Firstly, the limited space in the small compressor gas path did not permit the effective use of conventional total pressure and temperature probes for performance evaluation. Secondly, the short time available for development excluded some attractive corrective measures such as the redesign of some of the axial blade rows because the time required would have jeopardized the meeting of the tight development deadline. The first problem was overcome by a combination of limited wall static pressure measurements and an extensive use of numerical flow analysis codes. This approach proved to be quite cost-effective. The second was solved by the adaptation of an existing fully analytically-designed research axial stage to the first stage position in the axial compressor. Author

A86-23858#
METHOD OF SPARE PARTS - DIGITAL SIMULATION OF AIRCRAFT TURBINE ENGINE CONTROL SYSTEM
Y.-S. GUAN, J.-S. WARNG, and T.-C. LEE (Northwestern Polytechnical University, Xian, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 8 p. refs
(ASME PAPER 85-IGT-52)

The paper presents a new method of digital simulation of a control system. A computer program of an aircraft engine control system, as for an example, is implemented as a full authority digital simulator. The results of simulation show that the functions and applications of the simulator are extended as compared with those of the other type mathematical simulators. Author

A86-23859#
OPTIMAL CONTROL CHANGE OF STATE OF AIRCRAFT TURBINE ENGINE
T.-C. LEE and Y.-S. GUAN (Northwestern Polytechnical University, Xian, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 8 p. refs
(ASME PAPER 85-IGT-53)

The paper presents the application of linear quadratic regulator theory to the control of change of state of an aircraft turbine engine from rated to maximum. On the basis of the engine digital simulator, an optimal regulator of change of state is designed. The results of simulation of the optimal control system show that: during transient processes, maximum rotor speed deviation is decreased from 148 rpm to 4.5 rpm, thrust settling time is shortened from 7 seconds to 4 seconds, and transient response of turbine outlet temperature is refined from small overshot to monotonic, as compared with the original hydromechanical control system; thus, the improvement is apparent. Author

A86-23861#
DESIGN APPROACH FOR AN OPTIMUM PROP-FAN PROPULSION SYSTEM
G. L. BRINES (United Technologies Corp., Pratt and Whitney Div., East Hartford, CT) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 6 p. refs
(ASME PAPER 85-IGT-57)

The predicted potential performance of the Prop-Fan offers a major improvement in the energy efficiency of future, short-range to medium-range transports. This paper describes the approach taken in designing an optimum Prop-Fan propulsion system. Trade-offs in the configuration(s) and performance are discussed, as are the important aspects of integrating the propeller, gearbox, engine, inlet, exhaust, and nacelle. Realizing the impressive potential fuel savings of the Prop-Fan will require very careful

engine/airframe integration. Design options that will be compared are: a single-rotation versus counter-rotation arrangement, a tractor versus pusher installation, and wing versus fuselage mounting. In summary, the performance of turbofan powered and Prop-Fan powered, short-haul transports will be compared in detail by using fuel burn, operating costs, and noise as criteria. Author

A86-23883#

CONVERGENCE OF PERFORMANCE CALCULATION OF TWIN SPOOL TURBOJET AND TURBOFAN

X. ZHU, X. WANG, and Q. YAN (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 7 p. refs
(ASME PAPER 85-IGT-82)

A method of order-reduction for a multivariate nonlinear system used to calculate twin spool turbojet and turbofan performance is recommended. With the proper incorporation of other approaches, it can achieve satisfactory results in any flight condition and throttle setting. Compared with the experimentation data it can model the engine very well. Author

A86-23884#

RAPID CALCULATION OF ENGINE PERFORMANCE

J. ZHANG and X. ZHU (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 6 p.
(ASME PAPER 85-IGT-83)

A rapid calculation procedure for the design and off-design performance of turbojet and turbofan engines is developed. In the procedure, the general characteristics of components are established based on statistical data, and the engine working conditions are searched according to matching of these general characteristics. This method can be used to select cycle parameters in engine design, and has been employed in engine performance calculation program used in the prelimnary phase of engine design or airframe/engine integration design. Author

A86-23888#

STATE OF THE ART IN AIRCRAFT GAS TURBINE TECHNOLOGY

S. R. SAMPL and M. E. SHANK (United Technologies Corp., Engineering Div., East Hartford, CT) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 7 p. refs
(ASME PAPER 85-IGT-87)

The new series of turbofan engines use advanced technology features which enhance their attractiveness through reductions in the cost of ownership, noise, and pollution. Improvements in aerodynamics, mechanics, electronics, and materials technology reduce the cost of ownership via such factors as cost, reliability, durability, and operability. Primarily, advanced technology addresses fuel consumption, a parameter with a very large effect on direct operating cost. In addition, these advances do not trade convenience of operation for environmental acceptability. The advanced technology concepts used in the new commercial aircraft turbine engines offer both economic and environmental benefits. Author

A86-23899#

PREDICTION OF BLADE FLUTTER IN A TUNED ROTOR

J. XU and Z. SONG (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 7 p. refs
(ASME PAPER 85-IGT-100)

This paper is about blade flutter in a tuned rotor. With the aid of the combination of the three-dimensional structural finite element method, two-dimensional aerodynamic finite difference method, and strip theory, the quasi-steady models in which two degrees of freedom for a single wing were considered have been extended to multiple degrees of freedom for the whole blade in a tuned rotor. The eigenvalues solved from the blade motion equation have been used to judge whether the system is stable or not. The calculating procedure has been formed and, using it, the first stage rotating blades of a compressor where flutter had occurred, have been predicted. The numerical flutter boundaries are in good agreement with the experimental ones. Author

A86-23912#

FURTHER APPLICATIONS OF THE LUCAS FAN SPRAY FUEL INJECTION COMBUSTION SYSTEM

E. CARR (Lucas Aerospace, Ltd., Combustion Technology and Engineering Centre, Burnley, England) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 8 p.
(ASME PAPER 85-IGT-116)

An evaluation is made of the performance characteristics and design features of fan spray-type gas turbine combustor systems, with attention to a remotely piloted vehicle-engine application with combustion loadings five times greater than those of an initial application of the fan spray configuration. Results of flow visualization, combustion loading over a large air/fuel ratio range, and light-up under a wide range of simulated flight conditions, are presented for a total of six different fan spray combustor configurations. O.C.

A86-23917#

GAS TURBINE COMBUSTION EFFICIENCY

B. SCHLEIN (United Technologies Corp., Pratt and Whitney Div., East Hartford, CT) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 6 p. refs
(ASME PAPER 85-IGT-121)

A method of correlating combustor efficiency as a function of geometry and operating conditions is presented. A simple equation correlates all the data for a given engine type with a single parameter. The correlating parameter is a function of fuel flow, pressure, temperature and volume in a form similar to others in the literature. The unique feature of the correlating parameter is its use of internal gas temperature rather than the commonly used combustor inlet temperature. The result is an equation requiring an iterative solution since combustion efficiency is a part of the correlating parameter. With use of a computer this is easily handled. The correlation fits engine data over all flight conditions from high altitude, high Mach number to sea level idle. The correlation is compared to engine test data for several engines. Author

A86-23928#
LIFE PREDICTION FOR THE MAIN SHAFT OF AIRCRAFT TURBINE ENGINE
D. LIU (Chengdu Engine Co., People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 8 p. refs
(ASME PAPER 85-IGT-136)

The life prediction of the main shaft is described herein at the following three aspects: estimation of the fatigue life, testing method of the fatigue life and determination method of the service life for the main shaft. Based on the working practice, a block diagram of life determinating procedure for the main shaft, from which the prediction contents and steps of the fatigue life for the main shaft can be seen, is also included. Since the factors affecting the fatigue life of hardwares are very complicated, so only the main factor can be taken into consideration in the method of prediction of the life. Therefore, the emphasis is given to the need for a life prediction computation program which integrates the main shaft design, testing and application, so that the computation theory of the whole life prediction can be established on the foundation of the test practice and service experience. The life of main shaft can be predicted by calculation during the design stage. The local stress method and strain empiric formula are applicable for the prediction of the main shaft life in its elastoplastic area. Author

A86-23931#
DEVELOPMENT OF A NEW TECHNOLOGY SMALL FAN JET ENGINE
D. I. BOYD (Pratt and Whitney Canada, Longueuil) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 8 p.
(ASME PAPER 85-IGT-139)

The JT15D Turbofan Engine was created to power fast economical low noise executive jets for the general aviation market and currently powers the Cessna Citation I and II, Mitsubishi Diamond series and the Aerospatiale Corvette. This paper describes a higher thrust more fuel efficient version, the JT15D-5, with electronic fuel control systems and power up to a thrust level of 3200 lb. The Engine and its development program are described, including flight test and customer installations. Development problems and their solutions are covered. Author

A86-23938#
INVESTIGATION INTO THE CAUSE OF FAILURE OF A TURBOPROP IMPELLER IN SERVICE
H. Y. WONG (Glasgow, University, Scotland) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 7 p.
(ASME PAPER 85-IGT-147)

A 2-stage centrifugal flow turboprop Dart engine failed recently in service due to the failure of the low pressure impeller. Examination by various techniques including electron microscopy based on scanning, energy dispersive analysis of X-ray and transmission electron fractography indicates that the cause was metallurgical in nature, resulting from a material manufacturing defect followed by fatigue fracture and finally by tensile rupture of the material. Author

A86-23941#
PROPELLER DESIGN POINT CALCULATION METHOD FOR COMPARING TURBOFAN/PROPFAN ENGINE PERFORMANCE
M. F. SCHMIDT (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 11 p.
(ASME PAPER 85-IGT-150)

This paper presents a method for calculating the design-point performance of both single rotation and dual contrarotation propellers. Major propeller variables such as power loading, propeller efficiency, propeller tip speed, and propeller adiabatic compression efficiency, are accounted for and correlated. The resulting propeller performance is then combined with engine performance to yield propfan engine performance. The performance trades between power loading, propeller efficiency, propeller tip speed and propeller adiabatic compression efficiency are presented. Resulting performance for a given engine is presented for both single and dual contrarotation propellers. These engine performances can then be compared to advanced turbofan engines that utilize identical technology shaft power-producer engines. Author

A86-24226#
THE FORCED RESPONSE OF SHROUDED FAN STAGES
C.-H. MENQ, J. H. GRIFFIN, and J. BIELAK (Carnegie-Mellon University, Pittsburgh, PA) ASME, Design Engineering Technical Conference, Cincinnati, OH, Sept. 10-13, 1985. 6 p. refs
(Contract AF-AFOSR-0134; F33615-83-K-2316)
(ASME PAPER 85-DET-19)

This paper presents a general approach for modeling shrouded blade vibration that takes into consideration the nonlinear friction constraint at the shroud interface. In this approach, linear structures are characterized by receptances and shroud constraints by nonlinear impedances. The proposed methodology is presented in detail for simplified models of the bladed disk and shroud interface. The corresponding governing equations for the dynamic response are derived for both tuned and mistuned stages. As an example the method is applied to an idealized tuned stage. Two cases are considered, a lubricated shroud for which the coefficient of friction is equal to zero, and a frictionally constrained shroud. The effect of varying the shroud-to-shroud preload is studied. In the lubricated case nonlinear behavior is seen when vibrations are strong enough to result in separation of the shroud interfaces. In the case of finite friction there is a profound change in resonant frequencies when the preload is increased sufficiently to prevent gross slip at the shrouds. Author

A86-24712
EXCITATION OF BLADE VIBRATION BY FLOW INDUCED ACOUSTIC RESONANCES IN AXIAL-FLOW COMPRESSORS
R. PARKER, S. A. T. STONEMAN, and M. I. CARR IN: Unsteady aerodynamics of turbomachines and propellers; Proceedings of the Symposium, Cambridge, England, September 24-27, 1984. Cambridge, Cambridge University, 1984, p. 579-600. Research supported by Rolls-Royce, Ltd. and SERC. refs

When operating below design speed, with resulting blade mismatching, there arises a hitherto unrecognized blade vibration phenomenon in research compressors used in aircraft engine research which is clearly associated with acoustic resonances in the compressor annulus. Attention is presently given to the results of theoretical and experimental investigations concerning the effects of compressor annulus shape, as well as those of fluidmechanical/acoustical interactions furnishing the excitatory mechanism. This mechanism is influenced by the acoustic characteristics of the annulus and by the frequency of vortex shedding, which locks onto one of the possible resonances. O.C.

A86-24861
DESIGN AND DEVELOPMENT OF AN INERTIAL POWER SUPPLY UNIT FOR CARRIER-BASED AIRCRAFT
R. HOCKNEY, SR., D. EISENHAURE, S. ODEA, B. JOHNSON, and R. MARIANO (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: Intersociety Energy Conversion Engineering Conference, 20th, Miami Beach, FL, August 18-23, 1985, Proceedings. Volume 2 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 2.343-2.348.

An inertial power supply unit with a design operating lifetime of 20,000 hrs has been designed and built to replace a high maintenance cost electric battery system currently powering carrier-based aircraft inertial navigation systems. This flywheel unit, which has the form, aircraft fit, and function characteristics of the battery it is replacing, offers (in addition to better maintenance costs) unlimited charge/discharge cycling, long shelf life, and the capacity for both state-of-charge and bearing condition monitoring. O.C.

A86-25021
THE PROP-FAN INTRODUCES A NEW ENGINE GENERATION [DER PROPFAN LEITET EINE NEUE TRIEBWERKSGENERATION EIN]
P. SCHIMMING (DFVLR, Institut fuer Antriebstechnik, Cologne, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), Nov. 1985, p. 49-51. In German.

The increased importance of fuel costs with respect to the general operating costs of the airlines has led to the design of lighter and aerodynamically more favorable aircraft, and to the development of aircraft engines which consume less fuel. The development of the prop-fan in the U.S. during the early and mid-1970s led to the establishment of new engine concepts. The prop-fan itself is a propeller which has eight or more (as many as 12) blades. New design methods for these advanced propellers make it possible to obtain higher flight speeds at better propeller efficiencies than those provided by conventional propeller propulsion systems (turboprops). For this reason, prop-fan engines are becoming serious rivals of turbofan engines. Attention is given to propulsion system concepts for providing thrust, questions related to the selection of an engine for civil aviation, efficiency obtained on the basis of a design of propeller blades according to the newest aerodynamic viewpoints, and calculations for an engine design with minimum fuel consumption. G.R.

A86-25177#
RESEARCH AND DEVELOPMENT OF FJR 710 TURBO FAN ENGINE - SECOND PHASE
M. MATSUKI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 372, 1985, p. 12-19. In Japanese.

The construction, specification, and testing of the FJR 710 turbofan engine are described. The engine developed by the Research Association of Jet Engine Technology, Japan, will be tested with a STOL test aircraft. The basic engine parameters are fan pressure ratio of 1.45, overall pressure ratio of 19, turbine inlet temperature of 1250 C, and bypass ratio of 6.5 for reducing the fuel consumption. The schedule of the engine development including design, manufacturing, tests on performance and operation, and structural tests, such as static loading, blade containment, and overspeed and low cycle fatigue are illustrated. S.H.

A86-25192#
EXPERIMENTAL STUDY OF THE EFFECTS ON THE TURBOFAN ENGINE BY THE DISTORTION
T. ABE Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 374, 1985, p. 173-181. In Japanese, with abstract in English.

An experimental study was conducted to determine the effects of pressure distortion on the operation of a turbofan engine. In particular, the effects on the pressure ratio and efficiency of a two-stage axial flow fan and a five-stage axial flow compressor were studied. Two distortion indices on the orthogonal coordinate are indicated, and the circumferential distortion index is related to the radial distortion index. It is suggested that three kinds of distortion seem enough to cover all the distortion patterns encountered in flight. The pressure ratio and efficiency of a fan with distorted inflow decreased compared with those for clean inlet flow. However, the operation line and compressor efficiency hardly suffered from the distortion. C.D.

A86-25201#
AN ANALYTICAL METHOD OF THE CHARACTERISTICS OF THE TURBOFAN ENGINE COMPONENTS
T. ABE Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 376, 1985, p. 303-311. In Japanese, with abstract in English. refs

This paper presents an analytical method to estimate accurately the compressor air mass flow rates an high pressure turbine inlet temperature of a two-spool turbofan engine on the basis of the characteristics of a high-pressure turbine and a combustor. The off-design performance was used as the characteristic of a high-pressure turbine. The pressure loss rates and the combustion efficiency were selected as the characteristics of a combustor. The off-design performance was analyzed from the total pressure loss coefficient analysis of the stator and the blade, and design data. The proposed method was applied to a low bypass ratio two-spool turbofan engine and compared with the model compressor test data. The results proved to be useful for estimating turbofan-engine component performance. Author

A86-25219#
VIBRATION PROBLEMS OF JET ENGINE ROTOR SYSTEMS
T. MIYACHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 379, 1985, p. 439-448. In Japanese. refs

The characteristics of turbo and jet engine rotor systems and problems in their vibrations, and their countermeasures are described. Various possibilities of the vibration of the turbo engine rotor system are analyzed. The control methods of the vibration of the jet engine rotor system characterized include trim balance of the rotor during manufacturing, spectrometric oil analysis program and condition maintenance for monitoring the vibration of the rotor in flight, active clearance control using a full-authority digital engine control method, and a balancing method of the impulse of the rotor. S.H.

A86-25234#
A STUDY OF RAMJET ENGINE. III - AIR INLET PERFORMANCE AS THE ENGINE COMPONENT
K. FUNAKI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 381, 1985, p. 584-591. In Japanese, with abstract in English. refs

A computer program was developed for computing the performance of a fixed-geometry two-dimensional external compression supersonic ramjet-engine inlet, which permits the required air mass flow rate for the engine to operate at off-design conditions. The program can compute the quantity of possible air flow coming through the inlet under critical operating conditions as well as the required air flow for the ramjet engine to generate the combustion gas that will be exhausted through a jet nozzle of the engine operating under given engine conditions and critical air inlet operation. A correlation between the exponential function of the flight and design Mach numbers, and the gas properties was found, which makes it possible to predict the pressure recovery in a supercritical regime. The correlation was found to be in good agreement with the available experimental data on ramjet engines. Author

A86-26071#
FLAT RATING CONCEPT INTRODUCED IN THE GTX ENGINE
A. PRASAD and V. SUNDARARAJAN (Gas Turbine Research Establishment, Bangalore, India) Defence Science Journal (ISSN 0011-748X), vol. 35, April 1985, p. 163-170.

In bypass engines, the loss of thrust increases with increase in the inlet total temperature. The concept of variable cycle,

achieved by varying the maximum cycle temperature in order to increase the available dry thrust, is explained, together with its application to the GTX 37-14U engine design. The design principles of the GTX engine, which is a twin spool turbojet with a throttle ratio of 1.13 are briefly described and the engine performance at 288 K and 318 K is compared to that of a conventional design with a throttle ratio of unity. The variable cycle concept is presently recognized in the design of engines for combat aircraft, designed for supersonic cruise at altitude. Graphs of the performance analysis are included. I.S.

A86-26154#
THE RELATIONSHIP OF ULTRAFINE FILTRATION AND OIL DEBRIS MONITORING FOR HELICOPTER PROPULSION SYSTEMS
T. TAUBER (Technical Development Co., Glenolden, PA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 13 p. refs

Research data indicate that rolling-element bearing life can be extended considerably by improving lubricant filtration. It is pointed out that disposable ultrafine oil filters with ratings better than 7 micrometers absolute have been commercially available for some time and are being used in several helicopter engines. In the past, helicopter drive systems have been equipped with relatively coarse filters. The U.S. Army has conducted an extensive evaluation of ultrafine filters and advanced oil debris monitoring technology between 1978 and 1983. The test fleet was retrofitted with an advanced Oil Debris Detection System (ODDS). The U.S. Army ODDS program is discussed, taking into account splash-type vs. full-flow chip detection, component wear, and debris. The program demonstrated that failure progression of any component occurs over a considerably longer period of time than any one particular flight. G.R.

A86-26156#
T700 - A PROGRAM DESIGNED FOR EARLY MATURITY AND GROWTH POTENTIAL
E. E. MARTIN (General Electric Co., Turboshaft Engine Projects Dept., Lynn, MA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 18 p. refs

Work related to the development of an advanced turboshaft engine to be used in a utility type of helicopter was started by an American aerospace company in the 1960s. This engine, which later became the T700, was to provide a replacement for the T58, a successful but aging helicopter powerplant which originated in the 1950s. The U.S. Army needed a turboshaft engine with greatly improved capability relative to previous generation machines for its helicopters, and the T700 was developed to meet these requirements. Currently three turboshaft engine models have been qualified to power six military aircraft versions, while three turboshaft and two turboprop versions have been certificated for application on six civil aircraft. G.R.

N86-19323# Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Research and Testing Dept.
PERFORMANCE COMPUTATION OF TURBOFAN AND TURBOJET ENGINES IN OFF-DESIGN CONDITIONS
G. BRIDEL 11 Oct. 1984 28 p refs In GERMAN; ENGLISH summary
(F+W-FO-1746) Avail: NTIS HC A03/MF A01

A prediction method of underload performance of turbojet and turbofan engines based on gas dynamic relations was developed using mass flow rate, compression ratio, turbine inlet temperature, thrust, and fuel consumption. More precise prediction results can be obtained by incorporating compressor efficiency. A BASIC computer program is described and results are compared with existing data. Up to a throttling coefficient of 50% of the maximum thrust, the deviation with respect to the measured values falls within + or - 20%. The specific fuel consumption is improved in underload medium range but is increased at high throttling coefficients. Accuracy improvement is achieved with introduction of variable compressor and turbine efficiency. Author (ESA)

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A86-23186*# Princeton Univ., N. J.
LONGITUDINAL FLYING QUALITITES CRITERIA FOR SINGLE-PILOT INSTRUMENT FLIGHT OPERATIONS
A. BAR-GILL (Rafael Armament Development Authority, Haifa, Israel) and R. F. STENGEL (Princeton University, NJ) Journal of Aircraft (ISSN 0021-8669), vol. 23, Feb. 1986, p. 111-117. Previously announced in STAR as N83-30407. refs
(Contract NAS1-15864; NGL-31-001-252)

Modern estimation and control theory, flight testing, and statistical analysis were used to deduce flying qualities criteria for General Aviation Single Pilot Instrument Flight Rule (SPIFR) operations. The principal concern is that unsatisfactory aircraft dynamic response combined with high navigation/communication workload can produce problems of safety and efficiency. To alleviate these problems, the relative importance of these factors must be determined. This objective was achieved by flying SPIFR tasks with different aircraft dynamic configurations and assessing the effects of such variations under these conditions. The experimental results yielded quantitative indicators of pilot's performance and workload, and for each of them, multivariate regression was applied to evaluate several candidate flying qualities criteria. S.L.

A86-23346#
A STABLE DISCRETE-TIME ADAPTIVE OBSERVER APPLIED TO MULTIVARIABLE AIRCRAFT
P. N. NIKIFORUK, N. HORI (Saskatchewan, University, Saskatoon, Canada), and K. KANAI (Defense Academy, Yokosuka, Japan) IN: Dynamic systems: Modelling and control; Proceedings of the Winter Annual Meeting, Miami Beach, FL, November 17-22, 1985 . New York, American Society of Mechanical Engineers, 1985, p. 189-194. refs

The parameters and state variables of an unknown aircraft are estimated using an adaptive observer which is applicable to multivariable systems expressed in block observer form. The observer used is a simple extension of the single-variable situation to the multivariable case and requires neither the decomposition nor cyclicity of the system. This may make the design of a flight control system which needs the parameters and state vector of the aircraft as simple as one for single-variable systems. The results of simulation studies are given for the T-2 CCV with particular reference to the longitudinal aircraft motions. Author

A86-23771
THE USE OF ANALYTICAL METHODS TO ASSESS AIRCRAFT MANEUVERABILITY [VYUZITI ANALYTICKYCH PRISTUPU PRO POSOUZENI MANEVROVACICH SCHPNOSTI LETOUNU]
J. SALGA and J. SVEDA Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1985, p. 333-340. In Czech. refs

The equations of motion of an aircraft as a mass point are used to express the characteristics of three maneuvers: straight flight with acceleration, unsteady horizontal turn, and combat turn with variable energy. The actual aircraft is included in the calculation through the mean values of attainable overloads. Graphs of a general applicability are presented. B.J.

A86-23781
PROBLEMS IN RUDDER DESIGN FOR SMALL TRANSPORT AIRCRAFT [PROBLEMATIKA NAVRHU SMEROVEHO RIZENI U MALEHO DOPRAVNIHO LETOUNU]
M. PESAK Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1985, p. 403-407. In Czech.
The design of a rudder for use on a small transport aircraft manufactured in Czechoslovakia is described. In the design of the rudder, particular attention was given to case of flight with one inoperative engine, where the rudder has to counteract a considerable yawing moment due to thrust asymmetry. B.J.

A86-24148
FREQUENCY METHODS OF AIRCRAFT IDENTIFICATION [CHASTOTNYE METODY IDENTIFIKATSII LETATEL'NYKH APPARATOV]
L. M. BERESTOV, B. K. POPLAVSKII, and L. IA. MIROSHNICHENKO Moscow, Izdatel'stvo Mashinostroenie, 1985, 184 p. In Russian. refs
Mathematical models describing the motions of aircraft are reviewed, and methods for the experimental determination of the frequency characteristics of aircraft are discussed. Computational schemes for determining the parameters of the mathematical models from the frequency characteristics are presented which are based on an analysis of the amplitude-phase characteristics and balancing relationships. The accuracy of identificaton and the adequacy of the mathematical models are evaluated. V.L.

A86-24577#
THE STUDY OF ADAPTIVE CONTROL AUGMENTATION SYSTEM IMPLEMENTED WITH MICROCOMPUTER
W. WANG and S. XIAO Northwestern Polytechnical University, Journal, vol. 4, Jan. 1986, p. 23-33. In Chinese, with abstract in English. refs
The Hartmann and Drebs (1980) longitudinal adaptive control augmentation system neglected the influence of actuator dynamics, whihc is presently considered as a first-order inertial block. A simple but useful Kalman filter-based model for parameter estimation is also proposed through which computational requirements are decreased to 50 percent of the original. Attention is given to the microcomputer implementation of the scheme proposed; in order to satisfy real time criteria, the software employs module-structure fixed point operation and machine language. O.C.

A86-24588
PROPOSAL FOR THE CHOICE OF STATE VARIABLES FOR EQUATIONS OF MOTION OF AIRCRAFT IN MOVING AIR [EIN VORSCHLAG FUER DIE WAHL DER ZUSTANDSVARIABLEN IN DEN BEWEGUNGSGLEICHUNGEN VON FLUGZEUGEN UNTER WINDEINFLUSS]
R. BROCKHAUS (Braunschweig, Technische Universitaet, Brunswick, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 9, Nov.-Dec. 1985, p. 376-382. In German. refs
An attempt is made, by the exact definition of state variables for longitudinal and lateral motion, to achieve a more complete coupling between aircraft motion and wind. In addition to using the previously introduced wind angles alpha(W) and beta(W), two additional angles alpha(K) and beta(K) are introduced as 'inertial' components of the angles of incidence and sideslip. These new angles are defined using a series of Eulerian angles between flight path and body-fixed coordinates. The use of these variables in the equations of motion demonstrate the advantages of selecting them as state variables. The effect of wind motion on the aircraft is clarified thereby. C.D.

A86-24633#
THE EFFECTIVENESS OF VARIOUS CONTROL SURFACES IN QUASI-STEADY AND UNSTEADY FLOWS - APPLICATIONS [EFFICACITE DE DIFFERENTES SURFACES DE CONTROLE EN QUASI-STATIONNAIRE ET INSTATIONNAIRE - APPLICATIONS]
R. DESTUYNDER (ONERA, Chatillon-sous-Bagneux, France), R. BARREAU (Aerospatiale, Toulouse, France), and G. ANDERS (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) (NATO, AGARD, Meeting, 61st, Oberammergau, West Germany, Sept. 8-13, 1985) ONERA, TP, no. 1985-147, 1985, 69 p. In French. refs
(ONERA, TP NO. 1985-147)
Two large-scale half-models fitted with unsteady pressure sensors and static pressure taps were employed to study the effectiveness of various active control surfaces such as those being installed on modern transport aircraft. The studies covered the performances of spoilers with and without slots, flaperons, ailerons and trailing edge flaps and combinations of each from Mach 0.5 up to transonic speeds. A database was developed for defining semi-empirical corrections to models for the lifting and moment values for the control surfaces. Vibrations were induced using hydraulic actuators which induced rotations of up to 400 deg/sec, thereby imparting white noise over the 0-30 Hz range, harmonics, and pitching from 135-270 deg/sec. Angles of attack from -2 to +7 deg were examined, along with severe wing deflection. The excitations and data collection were entirely computer-controlled. Spoilers, which exhibited sufficient promise to encourage their continued development, were particularly effective when more than one were used. Additivity was also observed when flaperons were installed, provided an adaptive control law was defined for their use. M.S.K.

A86-25203#
DEEP STALL CHARACTERISTICS OF THE MU-300
T. HANAI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 377, 1985, p. 322-325. In Japanese.
The deep stall characteristics of the MU-300 Diamond aircraft are described. The MU-300 obtained type certificates from FAA in 1981, and from Canada, West Germany, and England in 1983, and has achieved a high angle of attack. The aerodynamic design, structural dimension, and flight test of the MU-300 are described. S.H.

A86-25204#
AERODYNAMIC CHARACTERISTICS OF GENERAL AVIATION AT HIGH ANGLE OF ATTACK WITH THE PROPELLER SLIP STREAM
N. MATSUO and S. HIRANO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 377, 1985, p. 326-332. In Japanese. refs
The aerodynamic characteristics of the FA-300 business aircraft at high angle of the attack with the propeller stream are described. The FA-300 offers two types, FA-300-700 for 340 HP, and -710 for 450 HP of the engine. The effects of the propeller slipstream on the high angle of the attack are discussed. S.H.

A86-25205#
STALL FLUTTER OF HELICOPTER BLADE
H. OKAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 377, 1985, p. 332-339. In Japanese. refs
The characteristics of dynamic stall and its effects on helicopters are discussed. The type of the dynamic stall, and the effects of the Reynolds number, Mach number, average angle of attack, vibration number, and the airfoil type on the dynamic stall are discussed. The calculation methods of the stall flutter, such as pitch damping method and aerodynamic simulation technique, and characteristics of the helicopter airfoil are analyzed. S.H.

A86-25213#
TRENDS OF ACTIVE CONTROL TECHNOLOGY
K. KANAI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 378, 1985, p. 391-398. In Japanese. refs

The characteristics of active control technology (ACT) are compared with the conventional control method in relation to the design of a unified flight control system. The advantages and performance characteristics of reconfigurable and restructurable systems of flight control are analyzed. The design method of the control configured vehicle (CCV) on the basis of the ACT is described. The applications of the ACT to the Advanced Fighter Technology Integration/F-16 control system and the CCV-104G aircraft are discussed. S.H.

A86-26136#
HELICOPTER ACTIVE CONTROL WITH BLADE STALL ALLEVIATION MODAL CAPABILITY
A. DANESI (Roma, Universita, Rome, Italy) and A. DANESI (Selenia-Industrie Elettroniche Associate, S.p.A., Pomezia, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 19 p. refs

An active modal control for high-performance helicopters in forward flight is presented. A blade stall alleviation control strategy based on the spectral data computed from the flexible blade structural mode of vibration measurements is employed to suppress the blade torsional motion associated with the stall flutter and to reduce the possibility of high angle of attack onset on the retreating blade. The restoring collective pitch commands are derived for processing the output data from an electrooptical laser sensor by means of a microprocessor performing the power spectral density real time computations; these data, obtained implementing an FFT algorithm and observed within a frequency window centered at the dominant torsional mode frequency, are employed as a measure of the actual vibrational level existing on the blade. An optimal control strategy is implemented in order to release the blade loads below the critical limits predicted for the blade stall onset. Author

A86-26147#
DFVLR FLYING QUALITIES RESEARCH USING OPERATIONAL HELICOPTERS
H.-J. PAUSDER and K. SANDERS (DFVLR, Institut fuer Flugmechanik, Brunswick, West Germany) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 16 p. refs

A flight test program has been conducted in the field of flying qualities research. The tests utilized the operational helicopters BO 105 and UH-1D of the DFVLR and the German Flight Test Center. The main advantage of operational helicopters is the reality of visual and motion cues for the pilot. The extensive flight tests had the objectives: (1) to assess the demands of missions, (2) to derive qualified flight test tasks, (3) to determine criteria for task performance evaluation, and (4) to establish anchorpoints for an examination of validity of a simulator results. An overview of the DFVLR test activities is presented. Exemplary results for each objective are shown. A definition of agility demands for missions and a task performance evaluation approach for 'dolphin' and 'slalom' are discussed. Author

A86-26160#
HELICOPTER MANEUVRE STABILITY - A NEW TWIST
M. R. SWALES and A. W. DEBUSE (Empire Test Pilots' School, Boscombe Down, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 18 p. refs

Modern helicopters, with their wide maneuver and speed envelopes, need to have their maneuver stability carefully assessed using up to date techniques which set realistic limits, easily respected by operational pilots. The phenomenon of maneuver stability is explained in theory and practice with a brief discussion on the classical flight test methods used in the past to establish acceptability criteria for a helicopter's maneuver stability. This approach is then extended to encompass modern helicopters capable of high sustained turn rates, negative g, having sophisticated automatic flight control systems, hingeless rotors, and the tandem rotor configuration. Modern maneuver stability flight test techniques which are taught to student helicopter test pilots are described with recommendations from typical flight test results including maneuver limitations and methods of communicating them to the helicopter pilot. Author

A86-26170*# Massachusetts Inst. of Tech., Cambridge.
HELICOPTER ATTITUDE STABILIZATION USING INDIVIDUAL-BLADE-CONTROL
N. D. HAM (MIT, Cambridge, MA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 7 p. NASA-sponsored research. refs

A theoretical study is presented on the application of the Individual-Blade-Control concept to helicopter attitude stabilization. The design of a system controlling blade flapping dynamics, and related testing of the system on a model rotor in the wind tunnel, is described. The control inputs considered are blade pitch changes proportional to blade flapping acceleration, velocity, and displacement. The effect of such a system on helicopter rotor damping-in-pitch, and angle-of-attack stability is then evaluated. It is shown that helicopter attitude stabilization is achieved, with a corresponding improvement in flying qualities. R.R.

N86-19324*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
COMPARISON OF PILOT EFFECTIVE TIME DELAY FOR COCKPIT CONTROLLERS USED ON SPACE SHUTTLE AND CONVENTIONAL AIRCRAFT
C. M. PRIVOZNIK and D. T. BERRY Feb. 1986 20 p refs
(NASA-TM-86030; H-1222; NAS 1.15:86030) Avail: NTIS HC A02/MF A01 CSCL 01C

A study was conducted at the Dryden Flight Research Facility of NASA Ames Research Center (Ames-Dryden) to compare pilot effective time delay for the space shuttle rotational hand controller with that for conventional stick controllers. The space shuttle controller has three degrees of freedom and nonlinear gearing. The conventional stick has two degrees of freedom and linear gearing. Two spring constants were used, allowing the conventional stick to be evaluated in both a light and a heavy configuration. Pilot effective time delay was obtained separately for pitch and roll through first-order, closed-loop, compensatory tracking tasks. The tasks were implemented through the space shuttle cockpit simulator and a critical task tester device. A total of 900 data runs were made using four test pilots and one nonpilot (engineer) for two system delays in pitch and roll modes. Results showed that the heavier conventional control stick had the lowest pilot effective time delays. The light conventional control stick had pilot effective time delays similar to those of the shuttle controller. All configurations showed an increase in pilot effective time delay with an increase in total system delay. Author

N86-19325*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLIGHT TEST OF A RESIDENT BACKUP SOFTWARE SYSTEM
D. A. DEETS, W. P. LOCK, and V. A. MEGNA (Draper (Charles Stark) Lab., Cambridge, Mass.) Jan. 1986 12 p refs Submitted for publication
(NASA-TM-86807; H-1338; NAS 1.15:86807) Avail: NTIS HC A02/MF A01 CSCL 01C

A new fault-tolerant system software concept employing the primary digital computers as host for the backup software portion has been implemented and flight tested in the F-8 digital fly-by-wire airplane. The system was implemented in such a way that essentially no transients occurred in transferring from primary to backup software. This was accomplished without a significant increase in the complexity of the backup software. The primary

digital system was frame synchronized, which provided several advantages in implementing the resident backup software system. Since the time of the flight tests, two other flight vehicle programs have made a commitment to incorporate resident backup software similar in nature to the system described in this paper. Author

N86-19326# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
DETERMINATION OF PERFORMANCE AND STABILITY CHARACTERISTICS FROM DYNAMIC MANEUVERS WITH A TRANSPORT AIRCRAFT USING PARAMETER IDENTIFICATION TECHNIQUES
J. H. BREEMAN, L. J. J. ERKELENS, and A. M. H. NIEUWPOORT 14 Mar. 1984 23 p refs Presented at AGARD Flight Mechanics Panel Symposium on Flight Test Technology, Lisbon, Portugal, 2-5 Apr. 1984
(Contract NIVR-1816)
(NLR-MP-84024-U; B8572246) Avail: NTIS HC A02/MF A01

A flight test program was executed with the Fokker F28 transport aircraft to investigate whether it is possible to determine performance and stability characteristics from dynamic maneuvers using parameter identification techniques, with sufficient accuracy for certification purposes. A research moving base flight simulator was used to select an optimal set of maneuvers. Flight test data was analyzed, using the two-step method which starts by reconstructing the aircraft flight path as the first step, followed by calculation of aerodynamic coefficients using regression analysis techniques. The flight test results compared with results derived from conventional test programs show that the goal is reached. Author (ESA)

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A86-23187#
WIND TUNNEL WALL INFLUENCE CONSIDERING TWO-DIMENSIONAL HIGH-LIFT CONFIGURATIONS
T. E. LABRUJERE, R. A. MAARSINGH, and J. SMITH (Nationaal Lucht- en Ruimtevartlaboratorium, Amsterdam, Netherlands) (ICAS, Congress, 14th, Toulouse, France, Sept. 9-14, 1984, Proceedings. Volume 1, p. 76-84) Journal of Aircraft (ISSN 0021-8669), vol. 23, Feb. 1986, p. 118-125. Previously cited in issue 22, p. 319, Accession no. A84-44935.

A86-23189*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMPOSITE STATISTICAL METHOD FOR MODELING WIND GUSTS
J. R. SCHIESS (NASA, Langley Research Center, Hampton, VA) (Flight Simulation Technologies Conference, St. Louis, MO, July 22-24, 1986, Technical Papers, p. 62-68) Journal of Aircraft (ISSN 0021-8669), vol. 23, Feb. 1986, p. 131-135. Previously cited in issue 19, p. 2843, Accession no. A85-40562. refs

A86-23265
AN IMPROVED SMOKE GENERATOR FOR AIRCRAFT TESTING
E. H. SHELBOURN (Douglas Aircraft Co., Long Beach, CA) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 14-1 to 14-4.

An improved smoke generator is described for on-aircraft testing of smoke detection systems and smoke clearing and penetration rates. A heater is added to an existing smoke generator in order to produce smoke that more realistically simulates real fire conditions. Tests demonstrated significantly earlier detection than with the unmodified generator. Author

A86-23380
NEW NOSE-IN AIRCRAFT GUIDANCE/DOCKING SYSTEM DEVELOPED
J. B. AMORETTI (Ugec, Paris, France) ICAO Bulletin, vol. 40, Dec. 1985, p. 32-34.

The development of the ground guidance and docking system UCRAFT for Charles de Gaulle International Airport is described. The system, using robotic techniques, is designed for platforms with a nose-in system and platforms which already contain an optical sight guiding system. The ICAO requirements and pilot recommendations for the design of the guidance and docking system are examined. The advantages UCRAFT provides for its users are discussed. I.F.

A86-23750
SIMULATOR DESIGN FEATURES FOR HELICOPTER LANDING ON SMALL SHIPS
D. P. WESTRA and G. LINTERN (Essex Corp., Orlando, FL) IN: Human Factors Society, Annual Meeting, 28th, San Antonio, TX, October 22-26, 1984, Proceedings. Volume 2 . Santa Monica, CA, Human Factors Society, 1984, p. 1018-1022. refs

The role of helicopters in the U.S. Navy has considerably increased in recent years, and many Navy vessels support helicopters. The problems which arise in general in connection with aircraft operations at sea are aggravated on small ships because of the confined landing area and the instability of the deck. The present paper is concerned with an experiment which initiates research at the Naval Training Equipment Center's Visual Technology Research Simulator (VTRS) into simulator design and use in teaching essential flight control skills for helicopter operations from small ships. The reported experiment investigates the performance of eight experienced pilots in the simulator. The obtained results will be used to aid in the design of future transfer-of-training experiments to ultimately determine design requirements for simulators used to train the task of landing helicopters on small ships at sea. G.R.

A86-23773
FLIGHT-MECHANICS PROBLEMS SOLVABLE BY A RESEARCH FLIGHT SIMULATOR [ULOHY Z MECHANIKY LETU RESENE NA VYZKUMNEM LETOVEM SIMULATORU]
V. TICHOPAD Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1985, p. 345-348. In Czech. refs

The use of research flight simulators to solve various design and research problems in flight mechanics is examined. Typical examples of such problems are reviewed, and the possibilities of solving them with the research flight simulator of the Czechoslovak Aeronautical Research and Test Institute are discussed. B.J.

A86-23845#
DISCUSSION ABOUT DYNAMIC SIMULATION TEST OF AN AERO-ENGINE CONTROL SYSTEM
C. H. WU and D. FAN (Northwestern Polytechnical University, Xian, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 4 p.
(ASME PAPER 85-IGT-30)

A discussion is conducted concerning the features and performance capabilities of hybrid, physical/digital methods of aircraft engine control system simulation. Attention is given to an illustrative implementation of such a simulation system encompassing real aircraft engine control systems, a mathematical model of the engine in computer code form, and 'transformer' interfaces between the control apparatus and the computer code, taking the forms of an electric motor/generator, a low inertia electric motor, or a hydraulic pump/motor. O.C.

A86-24638#
OPTICAL FIBERS APPLICATION TO VISUALIZATION OF FLOW SEPARATION INSIDE AN AIRCRAFT INTAKE IN WIND TUNNEL
M. PHILBERT, R. DERON, J.-P. FALENI, J.-B. BION, and H. SALAUE (ONERA, Chatillon-sous-Bagneux, France) (SPIE - The International Society for Optical Engineering and Association Nationale de la Recherche Technique, International Symposium on Optical and Electro-Optical Applied Science and Engineering, 2nd, Cannes, France, Nov. 25-Dec. 6, 1985) ONERA, TP, no. 1985-158, 1985, 8 p. refs
(ONERA, TP NO. 1985-158)

An experiment visualizing air flow separation in an aircraft air-intake is presented. This experiment was realized in a large industrial wind-tunnel. It uses optical fibers to bring a laser beam into the model, and an optical fiber endoscope to visualize images of the phenomenon. Some pictures showing changes of the air flow separation are presented for several aerodynamic conditions. Author

A86-24726
AERODYNAMIC TESTING CONFERENCE, 14TH, WEST PALM BEACH, FL, MARCH 5-7, 1986, TECHNICAL PAPERS
Conference sponsored by AIAA. New York, American Institute of Aeronautics and Astronautics, 1986, 419 p. For individual items see A86-24727 to A86-24765.

The present conference on aerodynamic testing apparatuses and methods considers current and planned wind tunnel capabilities at NASA Lewis, the estimation of unsteady forces on a cascade in three-dimensional turbulence, the test methods of the NASA Langley 0.3-m transonic cryogenic wind tunnel, testing experience at the National Transonic Facility, computational fluid dynamics code verification, progress with the NASA Lewis Altitude Wind Tunnel modeling program, the NASA Langley low turbulence pressure and supersonic low disturbance wind tunnels, and the effects of compressibility and freestream turbulence on boundary layer transition in high subsonic and transonic flows. Also discussed are the 'continuous sweep' pressure prediction technique, supersonic wind tunnel optimization, flexible wall nozzle design, hover-in-ground-effect testing for a full scale tilt-nacelle V/STOL model, accuracy in force testing in cryogenic wind tunnels, and experiments with a high performance canard airfoil with boundary layer trip and vortex generators. O.C.

A86-24739#
THE ROLE OF WIND TUNNEL TESTING IN FUTURE AIRCRAFT DEVELOPMENT
V. F. MEZNARSIC (McDonnell Aircraft Co., St. Louis, MO) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 127-133.
(AIAA PAPER 86-0750)

An assessment is made of various factors affecting the aerodynamic configuration development and wind tunnel testing of advanced fighter aircraft, with attention to such techniques as the use of low cost models during the conceptual design phase for high angle-of-attack stability and control trend evaluation, as well as the use of large scale, low speed models for refined development work in the high angle-of-attack regime. Design features and functions are noted for a powered model support whose blockage is comparable to that of an unpowered support, and a high speed swept blade support strut that eliminates aft end distortion problems common with sting installations. Flow visualization techniques employing flat sheet laser illumination have also been developed. O.C.

A86-24740#
FUTURE REQUIREMENTS OF WIND TUNNELS FOR AERONAUTICAL SYSTEMS DEVELOPMENT
M. L. BUCK and T. R. SIERON (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 134-140. refs
(AIAA PAPER 86-0751)

This paper explores the requirements for future wind tunnels based on an assessment of the performance capabilities and goals of advanced aerospace vehicles. Conventional fighters, bombers, transports and special purpose vehicles are considered. In addition, operational environments are postulated for hypervelocity vehicles. Typical flight corridors are shown with the associated flow density, such as, real gas effects, low density flow, and nonequilibrium flow. An evaluation of the flight regimes and consideration of the operational requirements provides the insight for identifying future wind tunnel requirements. The area where the most serious testing deficiencies exist is at hypersonic speeds. Several types of hypersonic facilities are outlined which could provide critical wind tunnel data for the development of future hypervelocity vehicles. An observation is made that Computational Fluid Dynamics will require wind tunnel data to define detailed flow phenomena and to provide validation and guidance on flow modeling. Author

A86-24742#
FUTURE REQUIREMENTS OF WIND TUNNELS FOR CFD CODE VERIFICATION
C. W. BOPPE (Grumman Aerospace Corp., Aircraft Systems Div., Bethpage, NY) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 160-172. refs
(AIAA PAPER 86-0753)

Merit of Computational Fluid Dynamics (CFD) in the aircraft development process is measured by the degree to which flight characteristics can be simulated for advancing performance and/or improving flight safety. Unfortunately, elements of flight instrumentation and testing compromise the data required for computational flow simulation code development and verification efforts. Wind tunnel data satisfy this requirement to a large extent, but care must be taken to properly account for idiosyncrasies associated with subscale testing. Clearly, any facility feature which improves ability to simulate flight characteristics will favorably impact data taken for CFD code verification. In addition, however, a need for higher density in data resolution is identified. Technology exists to resolve current constraints, but it is not clear that means can be implemented in a cost-effective manner or that multiple problems can be resolved simultaneously. Several case studies are described which highlight future test requirements for code validation. The appendix describes several CFD/wind tunnel/flight test comparisons. Author

A86-24746#
DYNAMIC SUPPORT INTERFERENCE IN HIGH ALPHA TESTING
L. E. ERICSSON and J. P. REDING (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 203-214. refs
(AIAA PAPER 86-0760)

Dynamic test results of aircraft models at high angles of attack are analyzed in regard to support interference effects. Single degree of freedom oscillatory tests in pitch or yaw are subject to the same type of support interference through the near wake recirculatory region as is experienced by slender bodies of revolution. Consequently, the measurements can be corrected for support interference using the same methodology. The support interference associated with rotary rigs used in coning experiments is of a different type, being stationary in nature rather than unsteady, with the coning motion inducing a displacement of the vortex wake

similar to that caused by sideslip in a static test. Performing static tests at varying incidence and sideslip angles with two alternate supports can provide the information needed to correct coning experiments for support interference. Author

A86-24756*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

SOME LESSONS LEARNED WITH WIND TUNNELS

M. L. SPEARMAN (NASA, Langley Research Center, Hampton, VA) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 316-326. refs (AIAA PAPER 86-0777)

An historical evaluation is made of the most significant developments in the use of wind tunnels for the development and analysis of missiles and aircraft since the 1940s. In addition to being instrumental in the discovery of unknown aerodynamic, aeroelastic and aerothermodynamic phenomena, wind tunnels have helped in the explanation of numerous effects, the development of new configurations and systems, and the furnishing of critical initial performance evaluations for a broad spectrum of aircraft and missiles. Attention is given to low speed planform tests, body-wing-tail studies, variable sweep wing investigations, transonic characteristics and problems, supersonic trim drag, and supersonic pitch-up, area ruling, and inlet effects. O.C.

A86-24765#

THE ACCURACY PROBLEM OF AIRPLANE DEVELOPMENT FORCE TESTING IN CRYOGENIC WIND TUNNELS

B. EWALD (Darmstadt, Technische Hochschule, West Germany) and G. KRENZ (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) IN: Aerodynamic Testing Conference, 14th, West Palm Beach, FL, March 5-7, 1986, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1986, p. 405-415.
(AIAA PAPER 86-0776)

The measurement accuracy attainable in wind tunnel testing is limited by tunnel flow quality, model quality, and balance accuracy. It is presently noted that considerable accuracy improvements are obtainable through the use of large wind tunnel models and careful adaptation of the balance ranges to the test requirements. The primary uncertainty in balance measurements is due to thermal effects in the balance that are considerably exacerbated by cryogenic wind tunnel conditions. Attention is presently given to cryogenic balance development efforts which are aimed at the avoidance of temperature gradients in the balance structure. O.C.

A86-25197#

A WORLD REVIEW ON AIR BREATHING ENGINE ALTITUDE TEST FACILITIES

Y. MIURA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 376, 1985, p. 251-266. In Japanese. refs

The current status and future prospects of the air breathing engine altitude test facilities are reviewed with an emphasis on the test cell main body. The principle of the air breathing engine altitude test and its methods including the direct connect and free jet methods are characterized. The testing facilities of the air breathing engine altitude in the U.S.A., England, and France are compared. S.H.

A86-26029

THE DEVELOPMENT OF AN ADVANCED HELICOPTER RESEARCH SIMULATOR

F. J. MALKIN (U.S. Army, Human Engineering Laboratory, Aberdeen Proving Ground, MD) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 213-216.
(SAE PAPER 841610)

The development of a research simulator for an advanced helicopter cockpit is described. The purpose of the simulator is to evaluate the impact on human performance of multifunctional controls and displays, to be implemented in a family of light military helicopters. The objectives of the research is to tailor the crew station by reducing control and display interaction required of the operators, and by maximizing information transfer. The control input devices to be evaluated include key pads, touch-sensitive screens, joy sticks, and voice-actuated controls. In addition, various display formats, the optimum number of displays required, their arrangement and location, the helmet-mounted and panel-mounted displays, speech input/output applications, manual versus automated control tradeoffs, and side-arm control considerations will be investigated. The configuration of the simulator, the crew station, and the experimenter's console are described. I.S.

A86-26148#

DFVLR HELICOPTER IN-FLIGHT SIMULATOR FOR FLYING QUALITY RESEARCH

B. GMELIN, G. BOUWER, and D. HUMMES (DFVLR, Institut fuer Flugmechanik, Brunswick, West Germany) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 20 p. refs

New missions for civil and military helicopters lead to increasing higher demands in the field of flying qualities. The necessary research activities require extensive ground-based simulations and flight tests in particular. For flight testing, operational helicopters and research helicopters with variable dynamic characteristics are used for specific tasks. In order to fulfill the research needs for future helicopter systems, in-flight simulators will play an important role in flying quality research. The intention of this paper is to discuss the need for and the tasks of an in-flight simulator for flying quality research with emphasis on DFVLR activities. The DFVLR in-flight simulator BO 105 ATTHeS is described including the model following control system design and realization. First results of a ground-based simulation program and flight tests are presented showing the efficiency of the concept and demonstrating the potential for future flying quality research. Author

A86-26149*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AIRCREW-AIRCRAFT INTEGRATION - A SUMMARY OF U.S. ARMY RESEARCH PROGRAMS AND PLANS

D. L. KEY and E. W. AIKEN (NASA, Ames Research Center; U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 22 p. Previously announced in STAR as N85-11004. refs

A review of selected programs which illustrate the research efforts of the U.S. Army Aeromechanics Laboratory in the area of aircrew-aircraft integration is presented. Plans for research programs to support the development of future military rotorcraft are also described. The crew of a combat helicopter must, in general, perform two major functions during the conduct of a particular mission: flightpath control and mission management. Accordingly, the research programs described are being conducted in the same two major categories: (1) flightpath control, which encompasses the areas of handling qualities, stability and control, and displays for the pilot's control of the rotorcraft's flightpath, and (2) mission management, which includes human factors and cockpit integration research topics related to performance of navigation, communication, and aircraft systems management tasks. Author

A86-26152#
WIDE-ANGLE, LOW-ALTITUDE FLIGHT SIMULATOR VISION SYSTEM FOR COCKPIT RESEARCH AND AIRCREW TRAINING
A. CORT and R. HAWTIN (Westland Helicopters, Ltd., Yeovil, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 13 p.

A low cost helicopter flight simulator capable of reproducing night vision goggle flight over a height range of 0 to 300 ft and with a lateral field-of-view of 270 degrees has been developed by the Westland vision system (Vistasim). A terrain image stored in a photographic transparency that is projected onto a spherical screen surrounding the simulator cockpit by the point source projection technique is used and a sharp, bright image is achieved using a low power monochromatic laser. A servomechanism producing 6 degrees of freedom of movement of the transparency with respect to the projection screen generates the illusion of movement. A computerized mathematical flight model of the aircraft provides the necessary interface between the pilot's controls and the servomechanism. Despite tradeoffs made between allowable rotation angles, transparency size, dome size, light power and image distortion, the system exceeds all but the most advanced CGIs in scene content and realism. R.R.

N86-18328*# National Aeronautics and Space Administration, Washington, D.C.
AERONAUTICAL FACILITIES CATALOGUE. VOLUME 2: AIRBREATHING PROPULSION AND FLIGHT SIMULATORS
F. E. PENARANDA and M. S. FREDA Dec. 1985 242 p 2 Vol.
(NASA-RP-1133; NAS 1.61:1133) Avail: NTIS HC A11/MF A01 CSCL 14B

Volume two of the facilities catalogue deals with Airbreathing Propulsion and Flight Simulation Facilities. Data pertinent to managers and engineers are presented. Each facility is described on a data sheet that shows the facility's technical parameters on a chart and more detailed information in narratives. Facilities judged comparable in testing capability are noted and grouped together. Several comprehensive cross-indexes and charts are included. Author

N86-18329*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CURRENT WIND TUNNEL CAPABILITY AND PLANNED IMPROVEMENTS AT LEWIS RESEARCH CENTER
D. N. BOWDITCH 1986 24 p refs Prepared for presentation at the 14th Aerodynamic Testing Conference, West Palm Beach, Fla., 5-7 Mar. 1986; sponsored by AIAA
(NASA-TM-87190; E-2844; NAS 1.15:87190) Avail: NTIS HC A02/MF A01 CSCL 14B

As the propulsion and power generation center of NASA, Lewis has designed its wind tunnels for propulsion research. Therefore, the 8 by 6 Foot Supersonic Wind Tunnel and the 10 by 10 Foot Supersonic Wind Tunnel provide the capability to test operating propulsion systems from Mach 0.4 to 3.5. The 9 by 15 Foot Wind Tunnel can investigate propulsion installation problems at the lower takeoff and landing speeds and provides an excellent anechoic environment to measure propeller and fan noise. The Lewis Central Air System provides steady air supplies to 450 psi, and exhaust to 3 in. of mercury absolute, which are available to the wind tunnels for simulation of jets and engine induced flows. The Lewis Icing Research Tunnel is the largest in the free world that can produce icing conditions throughout the year. Rehabilitation of the Altitude Wind Tunnel at Lewis would allow testing of propulsion systems in the upper left hand corner which would be a unique capability. Also, in a mothballed state at Lewis, the Hypersonic Tunnel Facility could provide the best simulation of nonvitiated Mach 5-7 test conditions available. Studies are currently being made of the Lewis facilities to identify enhancements of their research potential for the 1990's and beyond. Author

N86-18333# Air Force Human Resources Lab., Brooks AFB, Tex.
FLIGHT TRAINING SIMULATORS. EFFECTS OF TERRAIN ACCURACY ON SIMULATED RADAR IMAGE QUALITY Interim Technical Paper, Sep. 1984 - May 1985
P. M. CRANE Sep. 1985 18 p
(Contract AF PROJ. 614)
(AD-A160905; AFHRL-TP-85-28) Avail: NTIS HC A02/MF A01 CSCL 17I

This experiment evaluated the effect of terrain vertical accuracy on the quality and perceived training effectiveness of simulated radar images. Seven Air Force navigators judged the quality and training value of digital radar landmass imagery produced at six different levels of terrain vertical accuracy. Each image represented the simulated ground mapping radar image of a mountainous area viewed from an altitude of 10,000 feet. The results indicated that: (1) increasing terrain vertical accuracy above the current production standard did not significantly increase either the judged quality of the imagery or its perceived training value; and (2) decreasing terrain vertical accuracy below the current production standard significantly increased either the judged quality of the imagery or the perceived training value of the imagery. Although the results of this experiment do not provide any justification for more stringent accuracy requirements, it is recommended that this experiment be replicated using lower altitude imagery in which the effects of terrain evaluation are more pronounced. GRA

N86-19330*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE ROLE OF A REAL-TIME FLIGHT SUPPORT FACILITY IN FLIGHT RESEARCH PROGRAMS
A. L. MOORE Jan. 1986 14 p refs Presented at the AIAA Aerospace Sciences Meeting, Reno, Nev., 6-9 Jan. 1986
(NASA-TM-86805; H-1335; AIAA-86-0166; NAS 1.15:86805)
Avail: NTIS HC A02/MF A01 CSCL 14B

This paper presents some of the approaches taken by the NASA Western Aeronautical Test Range (WATR) of Ames Research Center to satisfy the ever-increasing real-time requirements of research projects such as the F-14, F-15, advanced fighter technology integration (AFTI) F-16, YAV-88, and the X-29A. The approaches include the areas of data acquisition, communications (video and audio), real-time processing and display, data communications, and tracking. Author

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A86-24841
DEVELOPMENT OF AUTONOMOUS POWER SYSTEM TESTBED
J. R. BARTON, M. E. LIFFRING (Boeing Aerospace Co., Seattle, WA), and T. ADAMS (Advanced Information and Decision Systems, Mountain View, CA) IN: Intersociety Energy Conversion Engineering Conference, 20th, Miami Beach, FL, August 18-23, 1985, Proceedings. Volume 1 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 1.466-1.471.

A power system testbed has been assembled to advance the development of large autonomous electrical power systems required for the space station, spacecraft, and aircraft. The power system for this effort was designed to simulate singleor dual-bus autonomous power systems, or autonomous systems that reconfigure from a single bus to a dual bus following a severe fault. The approach taken was to provide a flexible power system

design with two computer systems for control and management. One computer operates as the control system and performs basic control functions, data and command processing, charge control, and provides status to the second computer. The second computer contains expert system software for mission planning, load management, fault identification and recovery, and sends load and configuration commands to the control system. Author

N86-20196# Joint Publications Research Service, Arlington, Va.
ANALYTICAL EVALUATIONS OF ACCURACY IN DETERMINING AND PREDICTING PARAMETERS OF ARTIFICIAL EARTH SATELLITE MOTION USING ALTIMETER MEASUREMENT DATA Abstract Only
M. P. NEVOLKO and Y. L. MOSIN *In its* USSR Report: Space (JPRS-USP-86-001) p 91 13 Jan. 1986 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 23, no. 2, Mar. - Apr. 1985 p 310-314 Original language document was announced in IAA as A85-35246
Avail: NTIS HC A03

The proposed analytical estimation procedure is based on the methods of Porfir'ev and Smirnov (1968) and Bychkov and Boginskii (1972). It is shown that the main contribution to the prediction error according to the radius vector as well as along the orbit is from variations of atmospheric density. B.J. (IAA)

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A86-23274
GAS TURBINE FUELS AND THEIR INFLUENCE ON COMBUSTION
J. ODGERS and D. KRETSCHMER (Universite Laval, Quebec, Canada) Tunbridge Wells, England, Abacus Press (Energy and Engineering Science Series. Volume 5), 1986. 195 p. refs

The range of possible fuels from solids through liquids to gases is examined, and their possible applications to gas turbines of all types are considered. The influence of fuel properties on combustion performance is examined with the objective of providing information which will help in the design of a satisfactory combustion system. Anticipated fuels are considered, using measured data from existing fuels which bracket the forecast properties of the future fuels. C.D.

A86-23450
DETERMINATION OF THE SERVICE LIFE OF AVIATION OILS [OPREDELENIE SROKOV SLUZHBY AVIATSIONNYKH MASEL]
V. G. KUZNETSOV, G. T. NOVOSARTOV, A. I. ECHIN, and V. N. BAKUNIN Khimiia i Tekhnologiia Topliv i Masel (ISSN 0023-1169), no. 11, 1985, p. 39, 40. In Russian.

A procedure for determining the actual service life of the oils used in gas-turbine aircraft engines is proposed which is based on an experimental evaluation of the thermal oxidation stability of the oils using laboratory testing equipment. In particular, the method involves a study of the dynamics of changes in the contents of the principal additives and in the indices characterizing the service properties of the oil. Measurements of the additive contents and quality indices are made at certain intervals of time during the oxidation of oil in the laboratory. Each of the values is plotted against the time of oxidation, and the contents of additives an abrupt degradation of the oil properties are determined. This minimum additive content is then used as an oil performance criterion which determines the maximum allowable service life. Test results are presented for B-3V and IMP-10 aviation oils. V.L.

A86-23690
CURRENT CONCEPTS OF COMPOSITE APPLICATIONS IN AIRCRAFT AND ENGINES [SOVREMENNYE KONTSEPTSII PRIMENENIIA KOMPOZITNYKH MATERIALOV V LETATEL'NYKH APPARATAKH I DVIGATELIAKH]
A. S. VOLMIR Mekhanika Kompozitnykh Materialov (ISSN 0203-1272), Nov.-Dec. 1985, p. 1049-1056. In Russian. refs

Current applications of composite materials in aircraft structures and engines are briefly reviewed, with attention given to fiber-glass plastics, organic-fiber plastics, boron/aluminum, carbon composites, hybrid carbon/Kevlar composites, and other advanced composite materials. The performance characteristics of various composites are examined and compared with those of the traditional aircraft materials. The problems arising in the design, manufacture, and operation of aircraft, engines, and their components in the case of the partial or complete substitution of composite materials for the traditional structural materials are discussed. V.L.

A86-23823
FIBER-REINFORCED PLASTIC COMPOSITES FOR ENERGY ABSORPTION PURPOSES
P. H. THORNTON, J. J. HARWOOD, and P. BEARDMORE (Ford Motor Co., Dearborn, MI) (International Symposium on Composites: Materials and Engineering, University of Delaware, Newark, Sept. 24-28, 1984) Composites Science and Technology (ISSN 0266-3538), vol. 24, no. 4, 1985, p. 275-298. refs

The energy-absorbing characteristics in axial collapse of structures made from fiber-reinforced plastic (FRP) composites are reviewed from both the materials and the structural viewpoints. The type and nature of the fiber and resin, the geometry of the structure and the fiber arrangement affect significantly the energy-absorbing capability, but the data currently available are not yet sufficient to give a clearly unambiguous answer for a particular situation. An effective trigger mechanism is necessary to initiate stable collapse since thin-wall structures in particular are prone to unstable collapse. Methods are described to estimate the energy-absorbing potential of an FRP composite tructure. Author

A86-23868#
THE PRODUCTION OF JET FUEL FROM ALTERNATE SOURCES
H. R. LANDER, JR. (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) and H. E. REIF (Sun Refining and Marketing Co., Marcus Hook, PA) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 8 p. refs
(ASME PAPER 85-IGT-67)

The most significant potential source of aviation gas turbine fuels in the continental United States of America is the western oil shale located in the Rocky Mountain States of Colorado, Utah, and Wyoming. Nearly 600 billion barrels of recoverable oil is located in this area. This paper discusses the availability of oil shale and reviews the recovery, upgrading and refining schemes necessary to produce fuel which can be used in present-day aircraft. Other synthetic fuels are discussed with regard to the processing necessary to produce suitable fuels for today's high performance aircraft. Heavy oil and tar sand bitumen are likely to be refined in the next decade. Methods for producing suitable fuels are discussed. The chemical structure of these sources, whigh is basically cyclic, leads to the potential of heavier fuels with more energy per given volume and therefore longer range for certain aircraft. This exciting possibility is reviewed. Author

A86-23911#

TEST AND EVALUATION OF SHALE DERIVED JET FUEL BY THE UNITED STATES AIR FORCE

C. L. DELANEY (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 8 p. refs

(ASME PAPER 85-IGT-115)

An evaluation is made of the results obtained to date by the U.S. Air Force's shale-derived synthetic gas turbine engine fuel test program, with attention to the quality assurance measures being implemented to ensure that these fuels meet the JP-4 fuel standard defined by MIL-T-5624L. Compatibility has been established for the synthetic fuel with all materials currently used in aircraft fuel systems, storage facilities, and ground support equipment. A lubricity additive is, however, noted to be required for operation with the F100 engine of the F-15 and F-16 fighters. O.C.

A86-23922*# United Technologies Research Center, East Hartford, Conn.

FUEL DEPOSIT CHARACTERISTICS AT LOW VELOCITY

E. J. SZETELA, A. J. GIOVANETTI (United Technologies Research Center, East Hartford, CT), and S. COHEN (NASA, Lewis Research Center, Cleveland, OH) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 7 p. refs

(Contract NAS3-24091)

(ASME PAPER 85-IGT-130)

An experimental characterization has been made of the relationship between deposit mass, operating time, and temperature in studies of aviation gas turbine fuel thermal stability, in order to support fuel system designs that are more efficient through deposit buildup prevention. A novel thermal stability test apparatus has been developed for the determination of deposition rates over a range of temperatures, in tests of up to several hundred hours duration. In the case of heated stainless steel tubes at low velocity with Jet A fuel, the deposits obtained were thick, porous, and nonuniform. O.C.

A86-24636#

A NUMERICAL ANALYSIS OF SINGULAR STRESS FIELDS AT THE FREE EDGE OF LAYERED COMPOSITES

L. ANQUEZ (ONERA, Chatillon-sous-Bagneux, France) (European Mechanics Colloquia, Colloquium on Structure and Crack Propagation in Brittle Matrix - Composite Materials, 204th, Jablonna, Poland, Nov. 12-15, 1985) ONERA, TP, no. 1985-154, 1985, 16 p. refs

(ONERA, TP NO. 1985-154)

The stresses near a straight, free edge in (+alpha, -alpha) sub s composite laminates subjected to uniform axial strain are studied using a pseudo-three-dimensional finite element analysis. Based on the numerical analysis, expressions for the components of the stress tensor near the intersection of the interface and free edge are presented. The results indicate that, for the type of problem analyzed here, a singularity exists which is of the logarithmic, and not the power, type. C.D.

A86-24986*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

INTERLAMINAR FRACTURE OF COMPOSITES

T. K. OBRIEN (NASA, Langley Research Center; U.S. Army, Structures Laboratory, Hampton, VA) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 37, Feb. 1985, p. 61-69. Previously announced in STAR as N84-27835. refs

Fracture mechanics has been found to be a useful tool for understanding composite delamination. Analyses for calculating strain energy release rates associated with delamination growth have been developed. These analyses successfully characterized delamination onset and growth for particular sources of delamination. Low velocity impact has been found to be the most severe source of composite delamination. A variety of test methods for measuring interlaminar fracture toughness are being developed to identify new composite materials with enhanced delamination resistance. Author

A86-26158#

ARALL - A LIGHT WEIGHT STRUCTURAL MATERIAL FOR IMPACT AND FATIGUE SENSITIVE STRUCTURES

J. W. GUNNINK, M. L. C. E. VERBRUGGEN, and L. B. VOGELESANG (Delft, Technische Hogeschool, Netherlands) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 16 p. refs

A new hybrid material is obtained by incorporating 'high modulus' fibers into the bondline of laminated sheet material. This material is called ARALL (Aramid Reinforced Aluminium Laminate). Principally ARALL was developed to obtain a material with very good fatigue properties, in which possible cracks would grow very slowly. However, it turns out that ARALL is also a strong material with relatively low density. Preliminary tests have shown that the material also has promising impact and energy absorbing properties, which may qualify it as an interesting material for those applications where a high degree of ballistic tolerance is required. Aircraft design studies have indicated that, especially for fatigue sensitive areas such as the lower wing and the skin of a pressure cabin, ARALL is an attractive material. Weight savings of more than 30 percent should be attainable in practice. This paper gives a survey of the ARALL production process, and the properties of the material including mechanical properties, durability and some workshop aspects. Properties of joints and some applications of the material are also discussed. Author

A86-26159#

CORROSION PROTECTION OF HELICOPTERS THROUGH ORGANIC COATINGS

H. S. M. BALVERS (Sikkens Aerospace Finishes, Sassenheim, Netherlands) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 9 p.

For decades, aluminum-based alloys have been the most important construction material in the helicopter industry and in the aircraft industry in general. The reason for this situation is related to the favorable 'mechanical strength-weight' ratio provided by aluminum materials. However, a disadvantage of suitable aluminum alloys is a limited resistance against corrosion. The present paper provides a description of various materials which can be used as protective coatings for aluminum alloys, taking into account inorganic and organic coatings. After an evaluation of the various approaches avaiable to protect an aluminum alloy with the aid of a coating, it is concluded that organic coatings are indispensable to obtain the best possible protection for aircraft in general and helicopters in particular. G.R.

N86-18441*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

FIRE-RETARDANT DECORATIVE INKS FOR AIRCRAFT INTERIORS

D. A. KOURTIDES, Z. NIR (Makhteshim, Ltd., Beersheeba, Israel), and J. A. MIKROYANNIDIS (Patras Univ., Greece) Dec. 1985 14 p refs

(NASA-TM-88198; A-85414; NAS 1.15:88198) Avail: NTIS HC A02/MF A01 CSCL 07C

Commercial and experimental fire retardants were screened as potential fire retardants for acrylic printing inks used on aircraft interior sandwich panels. The fire retardants are selected according to their physical properties and their thermostabilities. A criterion for selecting a more stable fire retardant is established. Thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) are used to determine thermostabilities. Results show that the fire retardant formulations are more thermally stable than the acrylic ink control. It is determined that an ink formulation

containing a brominated phenol and carboxy-terminated butadiene acrylonitrile which has been modified with a brominated polymeric additive (BPA), yields the highest limiting oxygen index (LOI) of all the compounds tested. All of the fire-retardant formulations have a higher oxygen index than the baseline acrylic ink. Author

N86-18448*# Boeing Commercial Airplane Co., Seattle, Wash.
THE 737 GRAPHITE COMPOSITE FLIGHT SPOILER FLIGHT SERVICE EVALUATION Report, May 1981 - Dec. 1984
R. L. COGGESHALL Jul. 1985 84 p refs
(Contract NAS1-11668)
(NASA-CR-172600; NAS 1.26:172600; D6-53021; REPT-8) Avail: NTIS HC A05/MF A01 CSCL 11D

The flight service experience of 111 graphite-epoxy spoilers on 737 transport aircraft and related ground based environmental exposure of graphite-epoxy material specimens is covered. Spoilers have been installed on 28 aircraft representing seven major airlines operating throughout the world. An extended flight service evaluation program of 15 years is presently underway. As of December 1984, a total of 2,092, 155 spoiler flight hours and 2,954,814 spoiler landings had been accumulated by this fleet. Author

N86-18449*# Boeing Commercial Airplane Co., Seattle, Wash.
ENVIRONMENTAL EXPOSURE EFFECTS ON COMPOSITE MATERIALS FOR COMMERCIAL AIRCRAFT Report, Apr. 1982 - Mar. 1985
R. L. COGGESHALL Nov. 1985 82 p refs
(Contract NAS1-15148)
(NASA-CR-177929; NAS 1.26:177929; D6-53020) Avail: NTIS HC A05/MF A01 CSCL 11D

The effects of environmental exposure on composite materials are determined. The environments considered are representative of those experienced by commercial jet aircraft. Initial results have been compiled for the following material systems: T300/5208, T300/5209, and T300/934. Future results will include AS-1/3501-6 and Kevlar 49/F161-188. Specimens are exposed on the exterior and interior of 737 airplanes of three airlines, and to continuous ground-level exposure at four locations. In addition, specimens are exposed in the laboratory to conditions such as: simulated ground-air-ground, weatherometer, and moisture. Residual strength results are presented for specimens exposed for up to five years at five ground-level exposure locations and on airplanes from one airline. Author

N86-18451# Drexel Univ., Philadelphia, Pa. Ultrasonics Research Lab.
ULTRASONIC F-SCAN INSPECTION OF COMPOSITE MATERIALS Final Report, 9 May 1983 - 9 May 1984
J. L. ROSE, J. B. NESTLEROTH, and K. SUBRAMANIAN 13 Sep. 1985 102 p Original contains color illustrations
(Contract N68335-83-C-0739; F41-461)
(AD-A159974; NAEC-92-190) Avail: NTIS HC A06/MF A01 CSCL 17A

Composites are being used in high-strength, low-weight applications such as the aircraft industry. Difficulties arise in the nondestructive testing and evaluation of these materials because of their fibrous nature. Therefore, a study was connected to evaluate, improve, and optimize ultrasonic techniques for the detection of programmed delaminations and other defects in graphite/epoxy composite laminates. A pulse echo testing mode was used and C-scan results were analyzed. To overcome the limits of traditional C-scan, F-scanning (Feature scanning) was also used. This method examines many characteristic features of the ultrasonic waveform such as amplitude, frequency shifts, etc. Feature scanning has the potential to precisely locate and characterize the defects. Micrographic analyses were made to determine defective and good areas for correlation with the results obtain in the F-scan process. The results of the C-scan, F-scan, and photomicrographs showed an excellent correlation. Specific conclusions are drawn to assist future operators in conducting consistent and reliable C-scans. Situations where F-scanning might be suitable are also reviewed. Author (GRA)

N86-19447# Joint Publications Research Service, Arlington, Va.
POWDERED, SINTERED ALLOY MATERIALS DESCRIBED: DEVELOPMENT OF TITANIUM ALLOYS
M. YAMAZAKI and H. ONODERA *In its* Japan Report: Science and Technology (JPRS-JST-86-003) p 1-12 11 Feb. 1986 refs Transl. into ENGLISH from Kogyo Zairyo (Tokyo, Japan), v. 32, no. 13, Dec. 1984 p 25-31
Avail: NTIS HC A05/MF A01

As part of a system for the next generation, in parallel with the development of titanium alloys to meet the target performance of strength relative to high temperature (tensile strength/specific gravity), ductility and superplasticity properties, technological advances are studied for the manufacture of products such as compressor rotors with high yield, using superplasticity processing through powder metallurgy techniques. Techniques of alloy development as well as development status are explained, together with an outline of production techniques for components being studied at the Central Research Institute of Mitsubishi Metal Corporation. Author

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A86-22716
MAGNETIC TAPE RECORDING UNDER SEVERE ENVIRONMENTAL CONDITIONS [MAGNETBANDAUFZEICHNUNG UNTER ERSCHWERTEN UMVELTBEDINGUNGEN]
K. GROBBINK (Sangamo Electric GmbH, Essen, West Germany) IN: European Telemetry Conference, 7th, Boeblingen, West Germany, May 21-24, 1984, Reports. Part 1 . Wessling, West Germany, Arbeitskreis Telemetrie, 1984, p. 2.2-2.2.12. In German. refs

The design of magnetic tape recorders intended forse under severe environmental conditions is discussed. The requirements that must be met by such instruments and the particular stresses to which they are subject in use are examined. The components of a modern airborne tape recorder are described, including the tape drive, heads, current supply, power amplifier, and replay technology. C.D.

A86-23001
INSTITUTE OF ENVIRONMENTAL SCIENCES, ANNUAL TECHNICAL MEETING, 31ST, LAS VEGAS, NV, APRIL 30-MAY 2, 1985, PROCEEDINGS
Mount Prospect, IL, Institute of Environmental Sciences, 1985, 579 p. For individual items see A86-23002 to A86-23026.

Among the topics discussed are: clean room particle instrumentation; screening procedures and materials testing for space applications; and vacuum bakeout conditioning for molecular contamination control. Consideration is also given to: sources and measurements of surface contamination; contamination control in the fabrication of optical devices; garments and wipers; and electrostatics control. Additional topics include: particle identification in liquids and gases; particulates in gases; and contamination in liquids. I.H.

A86-23003
AVIP AIR FORCE THRUST FOR RELIABILITY
J. C. HALPIN (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: Institute of Environmental Sciences, Annual Technical Meeting, 31st, Las Vegas, NV, April 30-May 2, 1985, Proceedings . Mount Prospect, IL, Institute of Environmental Sciences, 1985, p. 206-218.

Methods for ensuring reliability of electronics components (Avionics Integrity Programs or AVIPs) on board military aircraft are discussed. The general principles incorporated into environmental stress screening programs for electronics applications are described in detail. Among the screening programs considered are: burn-in stress screening simulating realistic aircraft stresses, and enhanced environmental stress screening to detect components having the worst flaws. A testing approach for characterizing fatigue failures in printed wiring boards is illustrated in a block diagram. I.H.

A86-23011
EVOLUTION OF EMERGING ENVIRONMENTAL TESTING AND EVALUATION TECHNIQUES
A. H. BURKHARD (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Institute of Environmental Sciences, Annual Technical Meeting, 31st, Las Vegas, NV, April 30-May 2, 1985, Proceedings . Mount Prospect, IL, Institute of Environmental Sciences, 1985, p. 302-309. refs

The contemporary statistically based environmental test and evaluation techniques used to develop and qualify electronic systems will be too costly and time consuming for emerging equipment systems with much higher levels of reliability than current systems. The current emphasis on physical testing needs to be reduced and blended with the emerging analytical computerized tools to develop a more cost effective approach to evaluate the environmental suitability of electronic systems. It is proposed that an integrated approach based upon fracture mechanics concepts of latent defects growth and/or a nondestructive inspection techniques could yield such an approach. Author

A86-23015
UNSCREENED PART RELIABILITY RIVALS THAT OF SCREENED PARTS IN NEW DIGITAL AVIONICS
T. R. BRENNOM (Rockwell International Corp., Collins Avionics Div., Cedar Rapids, IA) IN: Institute of Environmental Sciences, Annual Technical Meeting, 31st, Las Vegas, NV, April 30-May 2, 1985, Proceedings . Mount Prospect, IL, Institute of Environmental Sciences, 1985, p. 332-336.

Early field operational data of Collins products on new Boeing 767 and 757 aircraft has shown stadard, full temperature range electrical parts have similar reliability levels as high reliability/screened electrical parts. This study is considered to be unique in that the only significant variable was part screening. Historical background into the use of failure rate sources at the Collins Avionics Divisions including some early screened part reliability results are included. Comparisons are made of actual and predicted field reliability levels of piece part failure rate data from early operation of the new Collins 700 Series Digital Products. A brief description of future needs in this area is also presented. Author

A86-23253
AIRBORNE INSTRUMENTATION MAGNETIC TAPE RECORDING THRU THE EARLY 90'S
W. D. WESSLER (Fairchild Weston Systems, Inc., Sarasota, FL) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 1-1 to 1-5.

Today's state-of-the-art airborne instrumentation tape recording is reviewed as background. Advantages and limitations of magnetic tape, as compared to other storage medium are considered, then practical present day longitudinal and helical recording is discussed. Following this a recorder manufacturer's projection of what the Flight Test Engineer can expect thru the early 1990's is presented. Bit rate, error rates, areal and volumetric packing densities as well as recorder weights and dimensions are considered. Author

A86-23256
USE OF VIDEO CASSETTE RECORDERS FOR COMBINED VIDEO AND PCM DATA RECORDING
R. J. MCQUILLAN (USAF, Flight Test Center, Edwards AFB, CA) and L. GALLO (Merlin Engineering Works, Palo Alto, CA) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 5-1 to 5-5.

Analog tape recorders are commonly used in aircraft flight testing to record PCM digital data. These recorders require considerable space and add significantly to the cost of test instrumentation. For limited test programs in densely packed aircraft, such as the modern fighter, the burden of a conventional reel to reel analog recorder is oppressive. With this condition in mind, the desirability of recording PCM data on a video cassette recorder surfaced. The video cassette recorder (VCR) offers greatly improved size and cost efficiency over conventional reel to reel recorders for many data acquisition requirements. Not only are cost and size improved, but several other benefits are realized. For instance, video cassettes are easily stored and transported. Automatic synchronization of the digital data and video images is inherent in the combined recording system. The system described in this paper makes use of a small electronic interface unit to combine and synchronize the video and PCM data signals. This composite signal is then recorded on a standard VHS video recorder. PCM data rates of up to thirty kilobits per second can be accomodated with only a minor reduction of picture area. Author

A86-23262
FURTHER DEVELOPMENT IN STORES SEPARATION DATA ACQUISITION AND REDUCTION
R. A. HERBERT (Aerospace Engineering Test Establishment, Medley, Canada) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 11-1 to 11-5.

The Canadian Forces flight test agency, Aerospace Engineering Test Establishment (AETE) was required to conduct a weapons clearance program on their CF18 aircraft in a very compressed time frame. One of the most time consuming of the activities was that of obtaining store separation in six degrees of freedom (6 DOF) using a single camera, photometrics technique. This paper describes some of the hardware and software improvements made to increase data throughput rates, improve data integrity and presentation, and data accuracy where possible. Author

A86-23266
A NEW HIGH TEMPERATURE SILICON ON SAPPHIRE TRANSDUCER FOR JET ENGINE CONTROL APPLICATIONS
A. J. PETERS (Bourns Instruments, Inc., Riverside, CA) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 15-1 to 15-4.

A new pressure transducer has been designed using silicon on sapphire technology. This transducer has been primarily designed for use in jet aircraft monitoring and control applications. The heart of this device is a single crystal sapphire substrate with epitaxially deposited silicon strain gages in intimate contact with the sapphire. The sapphire substrate becomes the pressure sensitive diaphragm and the strain gage resistance change is directly proportional to applied pressure. The transducer exhibits excellent linearity and low hysteresis due to the crystalline nature of the diaphragm. The transducer is fabricated using materials that have excellent thermal expansion match properties and is capable of operating at temperatures up to 500 degrees Fahrenheit. A means of monitoring diaphragm temperature is also included in the design. This paper contains a complete description of the fabrication process and the performance characteristics of this new device. Author

A86-23281
AIR FLOW AND PARTICLE TRAJECTORIES AROUND AIRCRAFT FUSELAGES. III - EXTENSIONS TO PARTICLES OF ARBITRARY SHAPE
W. D. KING (National Center for Atmospheric Research, Boulder, CO) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 2, Dec. 1985, p. 539-547. refs

Earlier work that produced generalized rules for obtaining trajectories of water droplets moving around aircraft fuselages has been extended to cover the case for particles of arbitrary shape. The parameters determining the major features of the trajectories are the fuselage radius and a generalized Stokes number that can be used to calculate an equivalent water drop size for particles of arbitrary shape and density. As for water drops, the maximum width of the shadow zone for sampling the particles is about one-fifth of the fuselage radius, and it occurs for those ice columns and plates of typical densities whose major dimensions are about 600 microns and 2 mm, respectively. Author

A86-23403
PREDICTION AND MEASUREMENT OF NEAR FIELDS FOR ANTENNAS ON STRUCTURES
L. C. CALMON (University College, London, England) and M. S. SMITH (Standard Telecommunication Laboratories, Ltd., Harlow, England) Institution of Electronic and Radio Engineers, Journal (ISSN 0267-1689), vol. 55, Nov.-Dec. 1985, p. 407-414. refs

Techniques for predicting near fields of antennas on limited ground planes, aircraft and other vehicles, have been developed. Wire grid modelling is used to calculate the current distribution over the metal structure, from which the fields close to the surface can be found. These field values could then be used in a quasi-static analysis to predict aperture penetration fields, with application to electromagnetic compatibility. A new form of electric field probe with an optical fibre link has been developed, which has been used to obtain experimental measurements to compare with the theoretical predictions. The agreement obtained is very close, confirming the theory and showing that the probe gives unperturbed and accurate measurements. Author

A86-23651
THE PROBLEM OF OPTIMIZING THE FINAL DESIGN MODIFICATIONS OF STOCHASTIC OSCILLATORY SYSTEMS [K ZADACHE OPTIMAL'NOI 'DORABOTKI' SLUCHAINYKH KOLEBATEL'NYKH SISTEM]
S. V. ARINCHEV and V. V. BYSTROV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 3, 1985, p. 3-7. In Russian. refs

The problem of optimizing the final design modifications of flight vehicle structures is formulated in mathematical terms with allowance for random factors. The optimization problem consists in ensuring a specified degree of system reliability with minimum design changes. An algorithm for solving the problem is proposed, and an example is included. V.L.

A86-23653
CALCULATION OF THE HEATING OF A LIQUID COMPONENT PARTIALLY FILLING A CONTAINER [RASCHET PROGREVA ZHIDKOGO KOMPONENTA, CHASTICHNO ZAPOLNIAIUSHCHEGO REZERVUAR]
N. L. BACHEV and A. A. KOZLOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 3, 1985, p. 13-17. In Russian.

The convective flux toward the free surface of the fuel tanks of aircraft on the ground or in flight produces convective flows in the liquid fuel and leads to the stratification of the liquid. Here, the flows of this kind are analyzed by solving numerically nonstationary equations of thermal convection without any assumptions concerning the flow structure. By using this approach, the heating of the liquid is determined for Re up to 7 x 10 to the 11th. V.L.

A86-23662
A THEORY OF LARGE AND FINITE DISPLACEMENTS OF BARS [TEORIIA BOL'SHIKH I KONECHNYKH PEREMESHCHENII STERZHNEI]
V. A. PAVLOV, S. A. MIKHAILOV, and V. G. GAINUTDINOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 3, 1985, p. 55-58. In Russian. refs

A theory for analyzing systems of bars under conditions of large displacements is presented which makes it possible to analyze the stress-strain state of a structure as a function of its deformability. In passing to the limit, the theory developed here is shown to yield Prandtl-Timoshenko equations. V.L.

A86-23663
SURFACES ON A NONRECTANGULAR FRAME [POVERKHNOSTI NA NEPRIAMOUGOL'NOM KARKASE]
A. D. TUZOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 3, 1985, p. 66-70. In Russian.

A method is presented for constructing a surface over a frame consisting of a set of nonrectangular areas whose opposite boundaries are of different parametric length. Equations for the portions of the surface are obtained by using the Boolean sum and tensor product methods. The equations presented here yield, as a particular case, a well-known equation for a rectangular region. V.L.

A86-23666
A QUICK METHOD FOR ESTIMATING HEAT TRANSFER TO A COOLANT [EKSPRESS-METOD OTSENKI TEPLOOTDACHI V OKHLADITEL']
A. B. SHIGAPOV and E. A. DAUTOV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 3, 1985, p. 79-84. In Russian. refs

A special nomogram and graphs are presented which provide a convenient way to calculate heat transfer to the coolant in ducts with a developed heat transfer surface, such as the cooling channels of aircraft engines. The method proposed here makes it possible to significantly reduce the time and effort required for calculating flow-type engine cooling systems. The method can be used for approximate estimates at the stage of preliminary design. V.L.

A86-23755
IN SITU METHODS FOR CRACK DETECTION IN THE MASTER CONNECTING RODS OF M 462 RF AIRCRAFT ENGINES [BEZDEMONTAZNI METODY ZJISTOVANI TRHLIN V HLAVNICH OJNICICH LETECKYCH MOTORU M-462 RF]
R. SYKORA Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1985, p. 165-171. In Czech.

The following methods are examined to determine their suitability for in situ crack detection in the master connecting rods of aircraft engines: (1) analysis of the vibration spectra from the cylinder containing the master connecting rod during engine operation; (2) analysis of the noise spectra and their changes with time during engine operation; and (3) analysis of the spectra of acoustic signals generated by impacts on the master connecting rod. Recorded spectra and frequencies characterizing cracks in the master connecting rods are presented. It is shown that each of the methods studied is capable of detecting cracks in master connecting rods. V.L.

A86-23759
USING WEAR PRODUCTS FOR ASSESSING AND PREDICTING THE CONDITION OF AIRCRAFT JET ENGINES [VYUZITI PRODUKTU OPOTREBENI K HODNOCENI A PROGNOZOVANI STAVU LETECKYCH PROUDOVYCH MOTORU]
L. SOTEK Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1985, p. 195-198. In Czech. refs

The principal problems associated with friction and wear in gas-turbine aircraft engines are examined, and the possibility of using certain tribological techniques for evaluating and predicting the condition of the engines is discussed. The possibilities afforded by such methods are demonstrated with reference to test results for two jet engines of the same type. V.L.

A86-23873#
THE FINITE ELEMENT STRESS ANALYSIS FOR SOLID-SHELL COMBINED PARTS IN AEROENGINES
Z. YIN, P. REN, and J. YIN (Nanhua Powerplant Research Institute, Zhuzhou, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 8 p. refs
(ASME PAPER 85-IGT-72)

In the finite element stress analysis of solid-shell combined parts in aeroengines, isoparametric solid elements, superparametric shell elements, solid-shell transition elements, and a series of coarse-fine mesh transition elements have been specially established and used so that the parts of complex shape can be modeled realistically and the amount of input data and computing time can be reduced. In this paper, the basic method used, the formulation of the various elements, and solutions to the equilibrium equations are presented, and the function and the structure of the general purpose program CACS are described. Author

A86-23879#
MEASUREMENT OF TURBINE BLADE TEMPERATURE USING PYROMETER
H. CHENG and C. DU (Shenyang Aeroengine Research Institute, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 7 p. refs
(ASME PAPER 85-IGT-78)

This paper presents the study of application of a self-made turbine blade pyrometer to measuring rotating turbine blade temperatures in a bed testing aeroengine. The study includes the temperature measuring principle and the pyrometer system; installation and adjustment of the double ball-floating type configuration optical head which goes through four different high temperatures bulkheads; and measurement of three kinds of temperature (the average blade temperature Ta, the average peak blade temperature Tap, and the maximum peak blade temperature Tmp) for all rotor blades of the turbine first stage. The experimental data analysis reveals that the first attempt of application of this pyrometer is successful. The measurement errors in the temperature range of 550-1200 C are within + or - 1 percent of calculated blade temperatures. Author

A86-23904#
A SURVEY OF ACCELERATED VIBRATORY FATIGUE TEST METHOD OF AERO-ENGINE COMPRESSOR BLADE
T.-Y. WU and Q.-X. LU (Nanjing Aeronautical Institute, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 6 p. refs
(ASME PAPER 85-IGT-105)

In this paper, a new accelerated fatigue test method based on Miner's Law is advanced, which is used for vibratory fatigue test of aeroengine compressor blading. By using this method, a sample life distribution can be obtained, and it saves time by about 50-60 percent. This approach is validated by experiments, and the test data are compared by two statistical methods, namely, the F-test and t-test. Author

A86-23909#
THE SOLUTION OF THE THERMAL ELASTIC-PLASTIC PROBLEM OF TURBINE DISK BY THE INCREMENTAL FINITE ELEMENT METHOD
S.-J. WEN (Shanghai University of Engineering and Technology, People's Republic of China), O. CHANG, and J.-Y. FANG (Fudan University, Shanghai, People's Republic of China) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 6 p. refs
(ASME PAPER 85-IGT-112)

In this paper, a stress analysis method and a computation program of the solution for the thermal elastic-plastic problem of a turbine disk in an aeroengine are presented by incremental finite element method. The method, which is suitable for the axisymmetric disk in the gas turbine, compressor, and steam turbine as well, may be used to compute the stress and displacement of a turbine disk at its thermal elastic or thermal elastic-plastic stage, its cracking revolving speed and limit load capacity, and the part which enters into the plastic zone first. The method may be used to compute the leading and unleading process, residual stress, and displacement, as well. It is important to analyze the strength of the turbine disk and its fracture characteristics. Author

A86-23933#
THE USE OF LASERS IN GAS TURBINE MANUFACTURING
D. S. DUVALL (United Technologies Corp., Pratt and Whitney Div., East Hartford, CT) ASME, Chinese Society of Aeronautics and Astronautics, and China National Aero-Technology Import and Export Corp., Beijing International Gas Turbine Symposium and Exposition, Beijing, People's Republic of China, Sept. 1-7, 1985. 7 p. refs
(ASME PAPER 85-IGT-141)

The laser is being increasingly used as a manufacturing tool in the fabrication of aircraft gas turbine engine components. Both solid-state pulsed and gas continuous-wave lasers are employed for a variety of manufacturing tasks including welding, cutting, hole drilling, surface alloying, and marking of parts for identification. In these applications, the laser provides increased productivity and reduced cost compared to conventional methods. Examples of specific uses of the laser in gas turbine fabrication are described along with the benefits achieved. Metallurgical effects associated with various laser processes are also discussed. Author

A86-23944#
THE EFFECT OF COMPRESSIBILITY ON SLENDER VORTICES [DER EINFLUSS DER KOMPRESSIBILITAET AUF SCHLANKE WIRBEL]
E. KRAUSE Rheinisch-Westfaelische Technische Hochschule, Aerodynamisches Institut, Abhandlungen, no. 27, 1985, p. 19-23. In German. refs

There is no or little information regarding studies concerned with the effect of compressibility on slender vortices and the vortex breakdown in compressible flows. However, detailed knowledge of the breakdown process in compressible flows is required to avoid uncontrollable flight conditions, in particular, in the case of aircraft with delta wings. In the present study, the attempt is made to provide a representation of the influence of compressibility on slender vortices. The employed approximation of the equations of motion makes it impossible to calculate the position of the breakdown point accurately. However, it is still feasible to determine in the analysis the most important differences with respect to the incompressible flow. A summary is provided of the results reported by Krause (1983, 1985) for slender vortices in incompressible flow, and the obtained corresponding relations for compressible flows are discussed. It is found that the breakdown of slender vortices in compressible flow is less rapid than in incompressible flow. G.R.

A86-23951
COMPARISON OF TWO TARGET CLASSIFICATION TECHNIQUES
J. S. CHEN and E. K. WALTON (Ohio State University, Columbus) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-22, Jan. 1986, p. 15-22. Research supported by the Ohio State University Research Foundation. refs
(Contract N00014-82-K-0037)

Radar target classification techniques based on backscatter measurements in the resonance region (1.0-20.0 MHz) are discussed. Attention is given to two novel methods currently being tested at the radar range of Ohio State University. The methods include: (1) the nearest neighbor (NN) algorithm for determining the radar cross section (RCS) magnitude and range corrected phase at various operating frequencies; and (2) an inverse Fourier transformation of the complex multifrequency radar returns of the time domain, followed by cross correlation analysis. Comparisons are made of the performance of the two techniques as a function of signal-to-error noise ratio for different types of processing. The results of the comparison are discussed in detail. I.H.

A86-24230#
THE VISCOELASTIC DAMPING TECHNOLOGY DESIGN GUIDE FOR AEROSPACE STRUCTURES
V. R. MILLER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), M. L. DRAKE (Dayton, University, OH), and J. SOOVERE (Lockheed-California Co., Burbank) ASME, Design Engineering Technical Conference, Cincinnati, OH, Sept. 10-13, 1985. 4 p. USAF-sponsored research.
(ASME PAPER 85-DET-104)

Viscoelastic damping technology has reached a state of maturity in which it serves as a design tool for the effective solution of resonant vibration problems. Unexpected vibration problems can therefore be solved without resort to extensive structural design modifications. A viscoelastic damping design guide is now available as Air Force Wright Aeronautical Labs TR-84-3089, 'The viscoelastic damping technology design guide for aerospace structures'. O.C.

A86-24231#
INTERACTIVE MODAL IMAGING PROCESS FOR VIBRATING STRUCTURES
D. K. RAO (USAF, Materials Laboratory, Wright-Patterson AFB, OH) ASME, Design Engineering Technical Conference, Cincinnati, OH, Sept. 10-13, 1985. 12 p. Research sponsored by the National Research Council. refs
(ASME PAPER 85-DET-110)

A major objective of Experimental Modal Analysis is to extract and display mode shapes of a structure. This paper presents development of a mode measurement method, called Modal Imaging Process (MIP). This is an on-line process that develops and displays the Modal Image of a Vibrating Structure directly. It uses roving vibration transducer(s) to measure amplitude and phase of vibrations at selected Surface Points. These transducers are integrated into a microcomputer which instantaneously creates/updates the Modal Image of the structure. Display of direct image of the vibrating structure will help the user to locate and correct any measurement errors on the spot, and view its true mode shape. Application of MIP to few aerospace structures are presented, and mode shapes measured by this method are compared with those displayed by offline FFT techniques. The MIP software is written in FORTRAN so that it can run on most of the inexpensive microcomputers. Author

A86-24236#
RESULTS OF RECENT RESEARCH ON DAMPED FAN BLADES
M. F. KLUESENER (Dayton, University, OH) and D. R. OETH (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) ASME, Design Engineering Technical Conference, Cincinnati, OH, Sept. 10-13, 1985. 8 p. refs
(Contract F33615-82-C-5022)
(ASME PAPER 85-DET-133)

Gas turbine engine airfoil high cycle fatigue failures are the result of forced or flutter-induced vibration. These vibration problems have been solved in some cases by using part-span shrouds. Recent advances in vibration damping technology indicate that additive damping techniques are a promising alternative to part-span shrouds. Evaluations were made of techniques and materials for providing high levels of intrinsic damping in the vibration modes of a gas turbine engine fan blade such that the part-span shrouds could be eliminated. An airfoil external constrained layer damping system was designed for the presently shrouded TF41 engine first-stage LP compressor blade to provide an additional system damping loss factor of 0.017, the analytically determined minimum required for flutter-free operation and acceptable forced response levels. An external damping system was applied to the blade, and the levels of modal damping achieved were experimentally measured. Author

A86-24246#
AUTOPARAMETRIC VIBRATION OF COUPLED BEAMS UNDER RANDOM SUPPORT MOTION
R. A. IBRAHIM (Texas Tech University, Lubbock) and H. HEO ASME, Design Engineering Technical Conference, Cincinnati, OH, Sept. 10-13, 1985. 8 p. refs
(Contract AF-AFOSR-85-0008)
(ASME PAPER 85-DET-184)

The dynamic response of a two degree-of-freedom system with autoparametric coupling to a wide band random excitation is investigated. The analytical modeling includes quadratic non-linearity, and a general first order differential equation of the moments of any order is derived. It is found that the movement equations form an infinite hierarchy set which is closed via two different closure methods. These are the Gaussian closure and the non-Gaussian closure schemes. The Gaussian closure solution shows that the system does not reach a stationary response while the non-Gaussian closure solution gives a complete stationary steady state response. In both cases the response is obtained in the neighborhood of the autoparametric internal resonance condition for various system parameters. Author

A86-24646#
MEASUREMENTS ACCURACY WITH 3D LASER VELOCIMETRY
A. BOUTIER, D. PAGAN, and D. SOULEVANT (ONERA, Chatillon-sous-Bagneux, France) (International Conference on Laser Anemometry - Advances and Application, Manchester, England, Dec. 16-18, 1985) ONERA, TP, no. 1985-171, 1985, 15 p. refs
(ONERA, TO NO. 1985-171)

Accuracy problems that arise in connection with the simultaneous measurement of the three local velocity components using a 3D laser velocimeter (LV), when the 3rd component is obtained by combining two coplanar components, are examined. The various ways to set up a 3D LV are summarized, and a particular fringe, three-color LV, with signals processed by counters, is described in more detail. Sources of error are analyzed, and ways to minimize them are considered. The successful application of an existing LV to study vortex breakdown downstream of a delta wing is reported. C.D.

A86-24663
HIGH-TEMPERATURE COMPOSITE DUCTS
G. F. HOWARTH, G. GLINECKI (Martin Marietta Corp., Baltimore, MD), and B. TAMBUSSI (Composite Structures Technology, Inc., Cherry Hill, NJ) Society of Manufacturing Engineers, Conference on Fabricating Composites, Hartford, CT, June 11-13, 1985. 12 p. (SME PAPER MF85-501)

The advantages and problems involved in the use of composites in aerospace applications are discussed. The problem of design is addressed, identifying the most important parameters. The individual steps involved in a tooling system analysis are given, and a materials/process matrix is presented and discussed. The advantages of graphite/polyimide for aerospace applications are examined. C.D.

A86-24667
ROBOTIC APPLICATIONS TO AUTOMATED COMPOSITE AIRCRAFT COMPONENT MANUFACTURING
B. SARH (Rohr Industries, Inc., Riverside, CA) Society of Manufacturing Engineers, Conference on Fabricating Composites, Hartford, CT, June 11-13, 1985. 18 p.
(SME PAPER MF85-506)

This paper considers robotic applications in aircraft prepreg composite structure fabrication. The process steps involved in automated prepreg production are described with a focus on process efficiency. For a typical composite structural shell, the number of different preprep pieces used is compared to the number of parts involved in a conventional metal structure, and the potential for automated production is shown. Specific process times and efficiencies for the process steps in fabricating a composite aircraft shell are calculated. Author

A86-24828
ELECTRIC POWER MANAGEMENT AND DISTRIBUTION FOR AIR AND SPACE APPLICATIONS
B. MEHL and E. HENDERSON (Sundstrand Corp., Rockford, IL) IN: Intersociety Energy Conversion Engineering Conference, 20th, Miami Beach, FL, August 18-23, 1985, Proceedings. Volume 1 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 1.374-1.381. refs

The historical growth of electric power systems for aircraft and space applications is briefly reviewed, and the technical issues involved in electric power management and distribution are discussed. The discussion covers bus architectures, power management components, power system controls, autonomous power management, transient reduction, and autonomous system reconfiguration. Particular attention is given to advanced electric power systems concepts and alternative implementations. V.L.

A86-24829
EFFICIENTLY MEETING ELECTRIC POWER NEEDS FOR FUTURE AIRCRAFT
I. S. MEHDI and P. J. LEONG (Boeing Military Airplane Co., Seattle, WA) IN: Intersociety Energy Conversion Engineering Conference, 20th, Miami Beach, FL, August 18-23, 1985, Proceedings. Volume 1 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 1.382-1.387.

Electric power in modern aircraft is becoming more and more important not only for powering essential systems but also to keep the aircraft in control. Stability Augmentation Systems in fly-by-wire aircraft cannot tolerate power interruptions as loss of power would cause loss of control of the aircraft itself. This paper describes the needs of the avionics and flight control systems in terms of quantity and quality of electric power required. Special requirements such as uninterruptible electric power and ultra-high reliability will be defined. These requirements will have to be met by incorporation of special features in the power generation and distribution systems, the control and protection and the utilization systems. It is significantly easier to provide uninterruptibility in dc-powered equipment. Author

A86-24830* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A NEW DIRECTION IN ENERGY CONVERSION - THE ALL-ELECTRIC AIRCRAFT
C. R. SPITZER (NASA, Langley Research Center, Hampton, VA) IN: Intersociety Energy Conversion Engineering Conference, 20th, Miami Beach, FL, August 18-23, 1985, Proceedings. Volume 1 . Warrendale, PA, Society of Automotive Engineers, Inc., 1985, p. 1.388-1.393. refs

This paper reviews recent studies of all-electric aircraft that use electric-only secondary power and flight critical fly-by-wire flight controls, and brings to the attention of the power system designer the intrinsic advantages of such aircraft. The all-electric aircraft is made possible by the development of rare earth magnet materials and fault tolerant systems technologies. Recent studies have shown all-electric aircraft to be more efficient than conventional designs and offer substantial operating costs reductions. Compared to present aircraft, an all-electric transport can save at least 10 percent in fuel burn. The cornerstone of an all-electric aircraft is the electric secondary power system. This paper reviews the major features of flight critical electric secondary power systems. Research required to lay the foundation for an all-electric aircraft is briefly discussed. Author

A86-25016
COMMUNICATION WITH LAND VEHICLES AND AIRCRAFT VIA SATELLITE [KOMMUNIKATION MIT LANDFAHRZEUGEN UND FLUGZEUGEN UEBER SATELLIT]
J. HAGENAUER and E. LUTZ (DFVLR, Institut fuer Nachrichtentechnik, Oberpfaffenhofen, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), Nov. 1985, p. 15-20. In German.

The present article is concerned with the feasibility to utilize satellites as a basis for large-area or even worldwide networks providing communication services to mobile participants in land vehicles, on ships, in aircraft, and in emergency situations. The current situation with respect to the considered communication services is examined, taking into account also the International Maritime Satellite Organization Inmarsat. An antenna with a size of about 10 cm would be sufficient for the smallest terminal on a ship. Antennas with such small dimensions would also be suitable for a use in the case of aircraft, automobiles, and emergency messages. Problems are related to the development of cost-efficient equipment; and research conducted by the DFVLR to overcome these problems is discussed. Developments regarding the satellite-aided communication with land vehicles are described, along with the advantages of satellite-aided communication in the case of aircraft. An improvement of communication with aircraft over the North Atlantic would make it possible to increase air traffic density and save fuel. G.R.

A86-25751
EQUIVALENT STIFFNESS AND DAMPING COEFFICIENTS FOR SQUEEZE FILM DAMPERS
E. J. HAHN (New South Wales, University, Kensington, Australia) IN: International Conference on Vibrations in Rotating Machinery, 3rd, Heslington, England, September 11-13, 1984, Proceedings . London, Mechanical Engineering Publications, Ltd., 1984, p. 507-514. refs

In aircraft engines, squeeze film dampers are increasingly used to achieve stabilization or appropriate vibration attenuation. Difficulties regarding the conduction of design studies can arise, because the damper forces are nonlinear functions of velocity and displacement. The present study is, therefore concerned with a general technique for linearizing the nonlinear element forces. The approach adopted for evaluating equivalent stiffness and damping coefficients employs energy dissipation and energy storage-release concepts. Attention is given to equivalent stiffness and damping coefficients, centrally preloaded dampers, a damper without centralizing spring - rigid rotor, and the application of the considered procedure to a general multimass rotor bearing system with a squeeze film damper. G.R.

A86-25865
GYROSCOPES MAY CEASE SPINNING
G. J. MARTIN (Litton Industries, Guidance and Control Systems Div., Woodland Hills, CA) IEEE Spectrum (ISSN 0018-9235), vol. 23, Feb. 1986, p. 48-53. refs

Laser gyroscopes have advantages compared to mechanical gyroscopes. Thus, they are more rugged and reliable, and, therefore, offer lower life-cycle costs. They are not yet more accurate than high-quality mechanical systems, but they have excellent development potential. Problems which can arise in the case of the spinning-rotor systems are related to their sensitivity to gravitational fields in the increasingly high-g environment of modern military aircraft. Optically based systems, on the other hand, have, in principle, no gravitational sensitivity and are in addition highly linear over a large dynamic range. The principles of operation of ring laser gyros (RLG) are discussed, taking into account the utilization of the Sagnac effect. Attention is given to the approaches found to overcome a number of engineering difficulties which arose in connection with the construction of RLG, techniques for limiting laser beam competition, aspects of geometry, and the current state of the art. G.R.

A86-26111#
THREE COMPONENT HOT-WIRE MEASUREMENTS IN THE WAKE OF A ROTOR MODEL
S. DE PONTE, A. BARON (Milano, Politecnico, Milan, Italy), and B. MIGNEMI (Italtel - Societa Italiana Telecomunicazioni S.p.A., Milan, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 10 p.

According to previous experience in hot-wire measurements in the flowfield of a rotor model in hover conditions, the paper describes problems connected with experiments of this kind and their possible solutions. In particular, it deals with the reliability of directional measurements related to triple hot-wire probes, the data validation procedure and validity of experimental results, the choice of probe orientation and some useful way of presenting the results in graphical form. Furthermore, the paper discusses one way to analyze the signal in statistical form in order to reconstruct turbulent or vortical structures without the usual 'smoothing' associated with ensemble averages due to the long-period 'wandering' of the wake. Author

A86-26121#
COMPOSITES IN THE DEVELOPMENT OF AGUSTA HELICOPTERS
F. GAMBARO and F. NATALIZIA (Elicotteri Meridionali S.p.A., Frosinone, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 17 p.

A development status and production capabilities assessment is presented for a state-of-the-art helicopter composite rotor manufacturer's highly automated development, fabrication and inspection facilities. Representative filament-wound and laminate composite products include a main rotor hub grip assembly for the A129 antitank helicopter, and the main and tail rotor blades, main rotor hub components, and tail unit assemblies of the EH101 military helicopter. The production plant encompasses warehouse, clean room, metal chemical treatment, finishing, thermal treatment, design office, and experimentation departments. O.C.

A86-26122#
MANUFACTURING CONTROL OVER THE REPRODUCTION OF HIGH INTEGRITY PARTS - A WAY TO IMPROVE THE SAFETY OF AERONAUTICAL PRODUCTS
C. BIGLIETTO and C. ARCARI (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Gallarate, Italy) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 19 p.

It is presently noted that close compliance with dimensional and specifications requirements in the production of helicopter components sometimes is not enough to ensure their interchangeability. It is recommended that the manufacturing operation sheets of a given component be closely monitored over their history in order to evaluate the effect of apparently minor changes. In addition, the original manufacturer must be considered the sole adequate resupply source for the most vital components. O.C.

A86-26125#
ELASTOMERIC ROD END BEARINGS - A SOLUTION FOR IMPROVING RELIABILITY AND MAINTAINABILITY
F. E. STAPLES, P. J. JONES, and W. E. SCHMIDT (Lord Corp., Aerospace Products Div., Erie, PA) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 25 p.

The extension of elastomeric bearing technology to rod ends, which is desirable for aircraft applications, especially control systems on helicopter rotors, is discussed. Elastomeric bearing development and the need for elastomeric rod ends are reviewed, and the types of elastomeric rod ends are described. The design and service advantages gained by elastomeric rod ends are addressed, and elastomeric rod end design and design refinement are considered. Service considerations and in-service applications of elastomeric rod ends are examined. C.D.

A86-26155#
THE DESIGN OF AN ADVANCED ENGINEERING GEARBOX
H. COCKING (Westland, PLC, Helicopter and Hovercraft Group, Yeovil, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 17 p. Research supported by the Ministry of Defence of England.

Equations are presented which show that gear and gearbox weights are proportional to the torque on the gear and gearbox respectively. An element of these equations called the 'configuration factor' can be derived from the gearing layout, and then used as a comparison of gearbox weights. Using this configuration factor, three features essential to any low weight gearbox have been identified. All triple reduction layouts, many using these three factors, have been analyzed using the configuration factor technique and a particular low weight configuration identified. The weight of this new configuration has been predicted and verified by traditional means and shows a 38 percent weight saving when compared to the existing Sea King Gearbox. Development programs are now nearing completion to enable this configuration to be incorporated into improved versions of certain current helicopters and new designs. Author

N86-18286# Joint Publications Research Service, Arlington, Va.
AVIAREMONT'S EFFORTS TO INTRODUCE LASER TECHNOLOGY
Y. KOLESNIKOV *In its* USSR Report: Transportation (JPRS-UTR-85-014) p 5-7 4 Dec. 1985 Transl. into ENGLISH from Vozdushnyy Transport (Moscow, USSR), 17 Sep. 1985 p 3
Avail: NTIS HC A04

To reduce the high cost of aircraft parts replacement, the Aviaremont Plant of Irkutsk plans to use lasers to resurface worn parts to save them from the scrap heap. Author

N86-18370# Consiglio Nazionale delle Ricerche, Florence (Italy). Ist. di Ricerca sulle Onde Elettromagnetiche.
REMOTE SENSING OF OIL ON SEA: LIDAR AND PASSIVE IR EXPERIMENTS
F. CASTAGNOLI, G. CECCHI, L. PANTANI, I. PIPPI, B. RADICATI, C. SUSINI, P. MAZZINGHI, and A. BARBARO *In* ESA Proceedings of EARSeL/ESA Symposium on European Remote Sensing Opportunities: Systems, Sensors, and Applications p 121-126 Jun. 1985 refs
Avail: NTIS HC A12/MF A01

A compact system for detecting and monitoring oil pollution on the sea from light aircraft using passive infrared remote sensing

was developed. Lidar marine environment and pollution monitoring potential was assessed in the laboratory. The low-power airborne system is suitable for day and night operations in quite good weather. It performs a real time detection of the oil, a mapping of the spill, and an identification of its thickest parts. A suitable Lidar system can be composed by an XeCl excimer laser with small dimensions, a low energy consumption, and 50 mJ energy per pulse. The detection system does not require an optical multichannel analyzer, but it is possible to operate with only three interferential filters: one for Raman scattering signal, the others for fluorescence signals, which are sufficient to identify the oil class. Author (ESA)

N86-18588# Naval Aerospace Medical Research Lab., Pensacola, Fla.
THE EFFECTS OF VOCAL VERSUS MANUAL RESPONSE MODALITIES ON MULTI-TASK PERFORMANCE Interim Report
G. R. GRIFFIN and J. D. MOSKO Feb. 1985 17 p
(Contract F58-528)
(AD-A159830; NAMRL-1312) Avail: NTIS HC A02/MF A01 CSCL 05J

The increasing complexity of display and control instrumentation in modern high performance aircraft has the potential to overload the human operator and result in diminished system performance. Interactive voice technology has been proposed as a method to reduce the high workload placed on the pilots of military aircraft. This report presents the results of an experiment designed to evaluate the effects on human performance of vocal versus manual response modalities on single and multiple tasks simulating some conditions of flight. Results indicated a significant increase in performance precision on a psychomotor task when a vocal, rather than a manual response mode was used on the simultaneous performance of multiple tasks. These results suggest that human performance on visually oriented multiple tasks requiring simultaneous execution may be improved if some of the work effort can be performed using a vocal input/output. GRA

N86-18599# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
EFFECTS OF NOISE AND WORKLOAD ON A COMMUNICATION TASK
D. H. ORRELL, II May 1985 81 p
(AD-A160743; AFIT/CI/NR-85-101T) Avail: NTIS HC A05/MF A01 CSCL 17B

Communication is of vital importance in the cockpit today. It is essential for pilots to be able to understand the messages sent to them. A major requirement of any aircraft voice communication system is the ability to deliver intelligible speech. In a loose sense, intelligibility may be defined as the understanding of spoken words (Webster, 1979). Several language factors affect intelligibility including vocabulary size, word frequency (familiarity) effects, number of response alternatives, number of syllables, phonetic elements and context (Webster, 1972). Other external considerations include equipment or design features and environment (Webster and Allen, 1972). With such a wide range of sources of influence, it is easy to understand the need for a reliable intelligibility test. One such test found to be particularly useful in studying the effects of aircraft noise has been the Modified Ryhme Test (MRT). GRA

N86-18630# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
A COMPARATIVE EVALUATION OF THE RELIABILITY IMPROVEMENT IN LINE REPLACEABLE UNITS WARRANTED UNDER THE F-16 RELIABILITY IMPROVEMENT WARRANTY M.S. Thesis
S. J. LEMKE Sep. 1985 98 p
(AD-A160830; AFIT/GLM/LSP/85S-44) Avail: NTIS HC A05/MF A01 CSCL 09C

This thesis examined the effects a reliability improvement warranty (RIW) had on the actual operational reliability of the warranted avionics equipment. To accomplish this, the most comprehensive DOD application of RIW to date, the F-16 RIW, was investigated. This study was designed to answer the question of whether or not a warranted weapons system was significantly more reliable than it would have been without the warranty. Specifically, the observed mean flight hours between failures (MFHBFs) and the observed reliability growths of the warranted F-16 equipment were compared to those of functionally similar non-warranted F-15 equipment. Also, the reliability growth of the F-16 warranted equipment was compared to that of other non-warranted F-16 equipment. The AMSAA Reliability Growth Model was used as a basis for the reliability growth analyses. Comparable life cycle time periods for each aircraft were studied, using AFM 66-1 D056 failure and flight time data. The results of the investigation indicated that, in general, the observed MFHBFs of the F-16 warranted equipment were statistically greater than the MFHBFs of the equivalent F-15 equipment. The same could not be concluded for the reliability growths of the F-16 and equivalent F-15 equipment. However, the reliability growth of the warranted F-16 equipment was found to be statistically greater than the reliability growth of the non-warranted F-16 equipment. Author (GRA)

N86-18699# California Univ., Irvine. Dept. of Mechanical Engineering.
AIRCRAFT MEASUREMENTS AND COORDINATION IN FASINEX Semiannual Progress Report
C. FRIEHE 10 Jul. 1985 6 p
(Contract N00014-85-K-0190)
(AD-A160789) Avail: NTIS HC A02/MF A01 CSCL 01C

As of July 10, 1985, the following progress was made on the proposal work: (1) wind and turbulence measurements on NRL Navy RP3A aircraft, BUNO 149670: (a) Radome pressure transducers purchased and installed with radome tubing, and wiring, test flights were performed to determine if pressure signals are active, (b) data system for aircraft tested, borrowed from National Center for Atmospheric Research (NCAR), Boulder, Colorado and shipped to NRL and made operational in the laboratory; (c) various environmental sensors obtained from USN China Lake, CA, for the NRL RP3A: Barnes infrared meterological radiometers; parts of dew point system; (2) FASINEX Aircraft Coordination: (a) site visit made to NAS Bermuda, facilities will be provided for transient FASINEX aircraft by NAS Bermuda; (b) cooperative agreement for joint use of NCAR Electra research aircraft by GALE and FASINEX projects worked out; (c) attended GALE planning meeting as FASINEX representative. GRA

N86-18728 Department of the Air Force, Washington, D.C.
MODULAR AIR SHUT-OFF VALVE Patent
J. J. BUCKLEY and W. T. SCOTT, inventors (to Air Force) 13 Aug. 1985 6 p Supersedes AD-D010489
(AD-D011935; US-PATENT-4,534,538; US-PATENT-APPL-SN-512083; US-PATENT-CLASS-251-62)
Avail: US Patent and Trademark Office CSCL 13A

A modular air shut-off valve, particularly useful within the air conditioning environmental control system of an aircraft, is provided. It consists of a housing sized for insertion into a duct of the air conditioning system, a vane pivotally mounted within the housing for pivotal movement between open and closed positions and having flexible portions along its edges contacting the housing in the closed position for providing a resilient seal and to allow pressure relief in the event of overpressure within the duct. Author (GRA)

N86-19490 Ohio State Univ., Columbus.
PERFORMANCE OF RESONANT RADAR TARGET IDENTIFICATION ALGORITHMS USING INTRA-CLASS WEIGHTING FUNCTIONS Ph.D. Thesis
A. MUSTAFA 1985 226 p
Avail: Univ. Microfilms Order No. DA8518995

The use of calibrated resonant-region radar cross section (RCS) measurements of targets for the classification of large aircraft is discussed. Errors in the RCS estimate of full scale aircraft flying over an ocean, introduced by the ionospheric variability and the sea conditions were studied. The Weighted Target Representative

(WTR) classification algorithm was developed, implemented, tested and compared with the nearest neighbor (NN) algorithm. The WTR-algorithm has a low sensitivity to the uncertainty in the aspect angle of the unknown target returns. In addition, this algorithm was based on the development of a new catalog of representative data which reduces the storage requirements and increases the computational efficiency of the classification system compared to the NN-algorithm. Experiments were designed to study and evaluate the characteristics of the WTR- and the NN-algorithms, investigate the classifiability of targets and study the relative behavior of the number of misclassifications as a function of the target backscatter features. The classification results and statistics were shown in the form of performance curves, performance tables and confusion tables. Author

N86-19583# National Aerospace Lab., Tokyo (Japan).
STUDY ON THE DIGITAL POSITION TRANSDUCER WITH OPTICAL TIME-DELAY PULSE
M. MAYANAGI Sep. 1985 40 p refs In JAPANESE; ENGLISH summary
(NAS-TR-878; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

A rotary optical position transducer employing a pulse technique time-multiplexor has been studied during the development of a Fly-By-Light (FBL) for the aircraft control system, the aim of which is to offer inherent resistance to environments of electromagnetic interference (EMI), electromagntic pulse (EMP) and lightening. The conventional absolute-type optical digital transducer causes difficulty in the interface technique between the transducer and other devices such as a computer. The transducer system described in this paper, which consists of a rotary position transducer unit, a fiber-optic cable, a light source unit, and an electronics interface unit, can improve this interface technique. The rotary transducer unit is an electrically passive device that is connected through optical fibers to the light source unit and the electronics interface unit, and that has many advantages of fiber-optic techniques. This paper studies basic problems in the development of the rotary transducer system. In particular, a basis for optimizing illumination irradiance and photo-detector characteristics is given, and the intrinsic performance of the transducer is quantitatively examined. Author 21

N86-19642 Engineering Sciences Data Unit, London (England).
GROWTH OF CRACKS UNDER CONSTANT AMPLITUDE FATIGUE LOADING: EXAMPLE CALCULATIONS
Mar. 1985 19 p refs Submitted for publication Sponsored in part by the Royal Aeronautical Society, London, England
(ESDU-84001; ISBN-0-85679-464-3; ISSN-0141-3996) Avail: ESDU

ESDU 84001 shows how crack growth data, such as those in this Sub-series, are used in practical situations; it provides two fully-worked examples using representative structural components to estimate the number of cycles to a specified crack length. The example shows the effect of a series of equally pitched riveted stiffeners on the progress of a crack across a sheet. Author

N86-19656# National Aeronautical Lab., Bangalore (India). Materials Science Div.
FATIGUE CRACK PROPAGATION UNDER SPECTRUM LOADING
R. SUNDER Mar. 1985 21 p refs
(NAL-TM-MT-8502) Avail: NTIS HC A02/MF A01

This project involved development of a method to predict the fatigue crack propagation process in thin-walled aircraft structural components under flight-by-flight loading. Extensive experimental test results provided the input for software development. They yielded evidence pointing to the complex nature of crack growth under spectrum loading and also provided the basis for procedures adopted for life prediction. A simple engineering method is proposed for estimating fatigue crack propagation life under random loading. Predictions are based on test data obtained under constant amplitude loading. Prediction accuracy favourably compares with that of available techniques. Computation time is extremely small, enabling the use of desktop computer for life predictions. Author

N86-19657# National Aeronautical Lab., Tokyo (Japan).
FUNDAMENTAL INVESTIGATION ON THE IMPACT STRENGTH OF HOLLOW FAN BLADES
T. IKEDA, T. MIYACHI, and Y. SOFUE Sep. 1985 23 p refs In JAPANESE; ENGLISH summary
(NAL-TR-879; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

Models of hollow fan blades were made and tested to prove that their strength is sufficient for use in real engines. The hollow blades were fabricated by diffusion bonding of two titanium alloy (6Al-4V-Ti) plates, one of which had three spanwise stiffners and the other being flat plate. The model was a non-twisted tapered blade. Impact tests were carried out on the hollow fan blade models in which the ingestion of a 1.5 pound bird was simulated. Solid blades with the same external form were also tested by similar methds for comparison. The results of these tests show that properly designed hollow blades have sufficient stiffness and strength for use as fan blades in the turbo-fan engine. Author

N86-19661*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
APPLICATION OF MATHEMATICAL OPTIMIZATION PROCEDURES TO A STRUCTURAL MODEL OF A LARGE FINITE-ELEMENT WING
J. L. WALSH Jan. 1986 43 p refs
(NASA-TM-87597; L-15930; NAS 1.15:87597) Avail: NTIS HC A03/MF A01 CSCL 20K

An optimization system is described that consists of the finite-element analysis program known as Engineering Analysis Language (EAL), the CONMIN optimization program, and a piecewise linear analysis. The optimization analysis system (OPTEAL) is used to minimize the mass of a transport wing subject to stress constraints for two static load conditions. The optimization procedure and the optimization analysis system (OPTEAL) are described and the optiomized results with fully stressed design results compared. Author

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A86-23289
AIRCRAFT FLOW EFFECTS ON CLOUD DROP IMAGES AND CONCENTRATIONS MEASURED BY THE NAE TWIN OTTER
A. M. DRUMMOND and J. I. MACPHERSON (National Aeronautical Establishment, Flight Research Laboratory, Ottawa, Canada) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 2, Dec. 1985, p. 633-643. refs

A theoretical model for the local flow velocity ahead of the wing quarter-chord point on the National Aeronautical Establishment Twin Otter has been developed and experimentally verified by flight measurements using a pitot-static equipped Particle Measuring Systems (PMS) canister. This flow velocity model was used to calculate drop trajectories and the resulting airflow effects on drop images and concentrations. Results indicate that drop images and concentrations measured by the Twin Otter are distorted in the worst case by no more than 25 percent for an unusually high aircraft lift coefficient of 0.79, and by only a few percent for lower values of this coefficient typical of normal flight. A method to correct water drop images and concentrations is described and results for a PMS probe mounted at one underwing station are presented. Author

A86-23291
COMPARISON OF SEA SURFACE TEMPERATURES OBTAINED FROM AN AIRCRAFT USING REMOTE AND DIRECT SENSING TECHNIQUES
P. A. SPYERS-DURAN (National Center for Atmospheric Research, Boulder, CO) and C. D. WINANT (California, University, La Jolla) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 2, Dec. 1985, p. 667-671. refs
(Contract NSF OCE-83-10639)

A comparison of sea surface temperatures is made between aircraft precision radiation thermometer (PRT-5) and aircraft deployed expendable bathythermographs (AXBT) drops. These observations were obtained using the NCAR King Air aircraft for an experiment in the Gulf of California during March 1984. The average difference between the sea surface temperatures reported by the first temperature observed in each AXBT drop and the PRT-5 is -0.07 C with a standard deviation of 0.57 C. The difference in temperature between the two observations increases at lower wind speeds. Based on 116 case studies, differences of 1-2 C exist between the surface and the upper meter of the ocean when wind speeds are less than 5 m/s. Author

A86-23292
DEDUCTION OF VERTICAL MOTION IN THE ATMOSPHERE FROM AIRCRAFT MEASUREMENTS
F. J. KOPP (South Dakota School of Mines and Technology, Rapid City) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 2, Dec. 1985, p. 684-688. refs
(Contract NSF ATM-80-25598; NSF ATM-83-11145)

Equations for deducing the vertical motion of air based on aircraft measurements are presented along with derivations. The equations are based on the aircraft equations of motion, but due to different assumptions, the resulting equations are quite different. The equations are then applied to the same aircraft data for comparison. Considerably different results are obtained. The equation based on Lenschow's work is believed to give the most reliable results. Author

A86-24631#
PROGRESS IN THE ANALYSIS OF ATMOSPHERIC TURBULENCE [PROGRES DANS LA CONNAISSANCE DE LA TURBULENCE ATMOSPHERIQUE]
G. COUPRY (ONERA, Chatillon-sous-Bagneux, France) (NATO, AGARD, Meeting, 61st, Oberammergau, West Germany, Sept. 8-13, 1985) ONERA, TP, no. 1985-164, 1985, 22 p. In French. refs
(ONERA, TP NO. 1985-164)

The report deals with measurement of time histories of turbulence, made by specially equipped aircraft, as well as with statistics of events deduced from a large number of commercial flights. A critical analysis of the methods used to reduce the flight data is developed, and proposals for improvements are suggested. It is shown that patches of turbulence for which a given level is exceeded are distributed following a Poisson distribution. Author

A86-26140#
DYNAMIC RESPONSE OF WINDTURBINE TO YAWED WIND
A. AZUMA, S. SAITO (Tokyo, University, Japan), and F. NAKAMURA (Toyota Motor Corp., Aichi, Japan) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 18 p.

Dynamic response of a two-bladed windturbine to yawed wind is analyzed by means of the local circulation method. The dynamic system is considered to consist of blade deformation, rotor rotational motion and yawing motion of the windturbine. The amplitude of the 2-P vibration in the bending moment and the rotor torque are more significant in the change of wind direction than in that of wind speed. The exemplified windturbine can follow the change of wind direction with fairly small response time. The inertial forces and moments are much smaller than the aerodynamic components because of the high rigidity of the present rotor. Author

A86-26175
NUCLEATION OF ICE CRYSTALS IN SUPERCOOLED CLOUDS CAUSED BY PASSAGE OF AN AIRPLANE
B. VONNEGUT (New York, State University, Albany) Journal of Climate and Applied Meteorology (ISSN 0733-3021), vol. 25, Jan. 1986, p. 98. refs
(Contract NSF ATM-79-21080; N00014-80-C-0312)

The proposed hypothesis of Vonnegut (1948) and Ludlum (1958) which states that cooling produced by adiabatic expansion of air disturbed by an aircraft causes an increase in ice crystal concentrations is examined. Temperature changes in the vortices produced at the tips of wings or propeller blades are estimated; an increase in the rate of crystal production after an increase in the tip speed of the propeller should be detected if aerodynamic cooling causes nucleation of ice crystals. The effects of aerodynamic characteristics of the blades and the blade angle of attack on temperature changes are investigated. I.F.

N86-18795# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
DESIGN METHOD FOR THE CALCULATION OF PERFORMANCES AND FLAP MOVEMENT OF FLEXIBLE WIND TURBINE BLADES [ONTWERPMETHODE VOOR DE BEREKENING VAN PRESTATIES EN KLAPBEWEGING VAN FLEXIBELE WINDTURBINEBLADEN]
T. VANHOLTEN and J. L. KOOMAN Feb. 1983 42 p refs
In DUTCH
(VTH-M-453) Avail: NTIS HC A03/MF A01

Performances, flap movements and loads of so-called flexible wind turbine blade were calculated in cases of right flow, flow with a velocity gradient, and oblique flow. The helicopter rotor based calculation method is simplified, and proves useful for first design estimates. The blades are schematized into intransformable blades attached to the hub using hinges with a spring stiffness such that the rotating natural frequency of the model blade flap movement is equal to the real blade natural frequency. Author (ESA)

N86-18861# Centre National d'Etudes Spatiales, Toulouse (France).
LONG-DURATION FLIGHTS USING INFRARED MONTGOLFIERES
P. MALATERRE *In* ESA The Seventh ESA Symposium on European Rocket and Balloon Programs and Related Research p 321-323 1985
Avail: NTIS HC A18/MF A01

A series of long-duration stratospheric balloon flights was carried out using infrared Montgolfiers. An IR Montgolfier is a hot-air balloon that captures solar radiation and IR Earth radiation as a heat source. A flight to study gravity waves lasted 52 days. Other uses include atmospheric data acquisition and radiation budget investigations. Author (ESA)

N86-18894# Air Force Environmental Technical Applications Center, Scott AFB, Ill.
LIMITED SURFACE OBSERVATIONS CLIMATIC SUMMARY (LISOCS). PARTS A, C-F: BREMEN INTERNATIONAL, WEST GERMANY Data Summary Report, Sep. 1974 - Aug. 1984
Jan. 1985 368 p
(AD-A159656; USAFETAC/DS-85/003) Avail: NTIS HC A16/MF A01 CSCL 04B

A statistical data summary of surface weather observation climatology for Bremen Intl., West Germany is presented. This summary is similiar to the Revised Uniform Summary of Surface Weather Observations (RUSSWO), but is based on data collected from limited-duty weather observing stations; i.e., those that take weather observations less than 24 hours a day, 7 days a week. The summary is in five parts: PART A, Weather Conditions and Atmospheric Phenomena; PART C, Surface Winds; PART D, Ceiling and Visibility; PART E, Psychrometric Summaries; and PART F, Pressure Summaries. Note that PART B, Precipitation, is omitted. See USAFETAC/TN-83/001 (AD-A132186), An Aid for Using the Revised Uniform Summary of Surface Weather Observations

(RUSSWOs), for complete descriptions of contents and instructions for use. Author (GRA)

N86-18896# Air Force Environmental Technical Applications Center, Scott AFB, Ill.
REVISED UNIFORM SUMMARY OF SURFACE WEATHER OBSERVATIONS (RUSSWO). PARTS A-F: GENERAL BILLY MITCHELL FIELD, WISCONSIN Data Summary Report, Jan. 1974 - Dec. 1983
Dec. 1984 425 p
(AD-A159658; USAFETAC/DS-84/038) Avail: NTIS HC A18/MF A01 CSCL 04B

A six-part statistical data summary of surface weather observation climatology for General Billy Mitchell Field, Wisconsin, consists of: PART A, Weather Conditions and Atmospheric Phenomena; PART B, Precipitation; PART C, Surface Winds; Part D, Ceiling and Visibility; PART E, Psychrometric Summaries; PART F, Pressure Summaries. See USAFETAC/TN-83/001 (AD-A132186), An Aid for Using the Revised Uniform Summary of Surface Weather Observations (RUSSWOs) for complete descriptions of contents and instructions for use. Author (GRA)

N86-18900# Air Force Environmental Technical Applications Center, Scott AFB, Ill.
REVISED UNIFORM SUMMARY OF SURFACE WEATHER OBSERVATIONS (RUSSWO). PARTS A-F: AVIANO AB, ITALY Data Summary Report, Jan. 1974 - Dec. 1983
Dec. 1984 383 p
(AD-A159662; USAFETAC/DS-84/037) Avail: NTIS HC A17/MF A01 CSCL 04B

A six-part statistical data summary of surface weather observation climatology for Aviano AB, Italy is presented. The summary consists of: PART A, Weather Conditions and Atmospheric Phenomena; PART B, Precipitation; PART C, Surface Winds; Part D, Ceiling and Visibility; PART E, Psychrometric Summaries; PART F, Pressure Summaries. See USAFETAC/TN-83/001 (AD-A132186), An Aid for Using the Revised Uniform Summary of Surface Weather Observations (RUSSWOs) for complete descriptions of contents and instructions for use. Author (GRA)

N86-18902# Oregon State Univ., Corvallis. Radiation Center.
GIEBELSTADT AIN GERMANY (WEST). LIMITED SURFACE OBSERVATIONS CLIMATIC SUMMARY (LISOCS): PARTS A, C-F Data Summary Report, Aug. 1974 - Jul. 1984
Feb. 1985 255 p
(AD-A159664; USAFETAC/DS-85/005) Avail: NTIS HC A12/MF A01 CSCL 04B

A statistical data summary of surface weather observation climatology for Giebelstadt Ain West, Germany is presented. This summary is similiar to the Revised Uniform Summary of Surface Weather Observations (RUSSWO), but is based on data collected from limited-duty weather observing stations; i.e., those that take weather observations less than 24 hours a day, 7 days a week. The summary is in five parts: PART A, Weather Conditions and Atmospheric Phenomena; PART C, Surface Winds; Part D, Ceiling and Visibility; PART E, Psychrometric Summaries; and Part F, Pressure Summaries. Note that PART B, Precipitation, is omitted. See USAFETAC/TN-83/001 (AD-A132186), An Aid for Using the Revised Uniform Summary of Surface Weather Observations (RUSSWOs), for complete descriptions of contents and instructions for use. Author (GRA)

N86-18909# Boeing Military Airplane Development, Seattle, Wash.
ATMOSPHERIC ELECTRICITY HAZARDS THREAT ENVIRONMENT DEFINITION Interim Report, Aug. 1982 - Mar. 1984
B. G. MELANDER and W. W. COOLEY Aug. 1985 155 p
(Contract F33615-82-C-3406)
(AD-A159739; AFWAL-TR-85-3052) Avail: NTIS HC A08/MF A01 CSCL 01B

This document provides definition of the atmospheric electricity threat environment as part of the Atmospheric Electricity Hazards Protection (AEHP) program. This issue contains an initial atmospheric electricity threat to be used for aircraft based on measurement of: (1) the lightning threat at the ground, and (2) the static electrification threat at altitude. The experimental basis for this threat is critically reviewed. Recommendations are made for future work in atmospheric electricity environments to refine and improve understanding of aircraft AEH environments. GRA

N86-18910# National Center for Atmospheric Research, Boulder, Colo.
MICROBURST WIND SHEAR MODELS FROM THE JOINT AIRPORT WEATHER STUDIES (JAWS) Final Report
W. FROST, H. P. CHANG, K. L. ELMORE, and J. MCCARTHY Jun. 1985 198 p
(Contract DTFA01-82-Y-10513)
(AD-A159758; DOT/FAA/PM-85/18) Avail: NTIS HC A09/MF A01 CSCL 04B

Multiple Doppler radar data collected during the Joint Airport Weather Studies (JAWS) Project is used to synthesize the three-dimensional wind in the region of a microburst. A six-degree-of-freedom numerical aircraft model having characteristics similar to Boeing 727 series aircraft is used to investigate jet transport aircraft response to microburst winds during simulated approaches and departures. Simple pilot control laws are used to adjust thrust, pitch, roll, and yaw so as to maintain given approach or departure parameters. Generally, when horizontal wind shear along the approach or departure path is .0001/s or greater, the model is unable to maintain the desired approach path and suffers a significant reduction in climb performance during a go-around or departure. Although the mean wind shear along a path gives a good qualitative measure of the wind shear threat to a jet transport, different paths with similar mean shears can yield markedly different results, as do the same paths with similar mean shears can yield markedly different results, as do the same paths through the microburst at different times, emphasizing the fine temporal and spatial scale of microburst winds. Finally, during the approximate 30 s period required for the aircraft to traverse the region of highest horizontal shear, time variations in the microburst wind field are shown to insignificantly affect the modelled flight path because the traverse period is a short time compared to the life time of a microburst. GRA

N86-18912# Air Weather Service, Scott AFB, Ill.
CATALOG OF AIR WEATHER SERVICE TECHNICAL DOCUMENTS
Jul. 1985 138 p
(AD-A159881; AD-E440298; AWS/TC-85/001) Avail: NTIS HC A07/MF A01 CSCL 04B

This catalog lists technical documents produced by or for the Air Weather Service and its subordinate units. Documents listed include technical reports, technical notes, data summaries, project reports, special studies, forecaster memos, follow-on training programs, microcomputer programs, and hand calculator programs. It includes availability data, ordering instructions, historical section. GRA

N86-18921# Air Force Geophysics Lab., Hanscom AFB, Mass.
SOME MICROPHYSICAL PROCESSES AFFECTING AIRCRAFT ICING Final Scientific Report, 1 Oct. 1981 - 30 Sep. 1984
H. J. SWEENEY and I. D. COHEN 8 May 1985 45 p
(AD-A160375; AFGL-TR-85-0100; AFGL-ERP-914) Avail: NTIS HC A03/MF A01 CSCL 04B

This report summarizes work done as part of the aircraft icing probabilities program. It contains a look at icing in layer-type clouds, a comparison of Particle Measuring System (PMS)2-D data from two flights. and a look at additional data obtained from researchers in the Federal Republic of Germany. The parameters measured in a warm and cold layer-type cloud near Peoria, IL are analyzed and compared. Liquid water content (LWC), cloud depth, particle diameter and particle concentration are compared. Variations of these parameters are compared. In mature clouds, where droplet sizes are approximately equal, the LWC is directly related to the number concentration. The icing rate, LWC and droplet size all increase as a function of height above cloud base. Synoptic patterns and PMS 2-D data obtained on two flights are compared. The first flight, made near Greensboro, NC was in an area of heavy precipitation. The large particles present produced very little icing. The other flight, near Flint, MI was in an area which was experiencing only spotty precipitation. The aircraft, however, experienced moderate icing. Data gathered on aircraft observations in the Federal Republic of Germany are examined. The data show that in strong icing situations, there are many particles with diameters of 10 to 20 microns. The results match those obtained by our research flights. GRA

N86-18923# Air Force Geophysics Lab., Hanscom AFB, Mass.
IN-FLIGHT TURBULENCE DETECTION Final Scientific Report, 10 Oct. 1983 - 30 Sep. 1984
A. R. BOHNE 8 Mar. 1985 61 p
(Contract DA PROJ. 667-0)
(AD-A160380; AFGL-TR-85-0049; AFGL-ERP-909) Avail: NTIS HC A04/MF A01 CSCL 04B

A limited set of radar and aircraft data acquired during the 1981 and 1982 Joint Agency Turbulence Experiment are used to compare incoherent and coherent radar methods for atmospheric turbulence severity estimation. Time series of ground-based radar in-phase and quadrature signal return data are processed by Doppler (Fast Fourier Tranform) and incoherent (R-meter with and without noise correction) methods to determine Doppler spectrum variance. These variance data serve as input to a turbulence algorithm to derive estimates of turbulence severity. These estimates are then compared with in-situ aircraft measurements. Results show the order of preference for the radar methods is Doppler, R-meter with noise correction, and R-meter without noise correction. The R-meter without noise correction method must be considered unreliable since it results in large overestimates of turbulence severity when the signal to noise ratio is less than about 12 dB. The R-meter with noise correction method generally duplicates well the results derived from Doppler analysis and may be considered a reasonable alternative when Doppler capability is not available. GRA

N86-18924# Air Force Geophysics Lab., Hanscom AFB, Mass.
JOINT AGENCY TURBULENCE EXPERIMENT Final Report, 1 Oct. 1981 - 30 Sep. 1984
A. R. BOHNE 21 Jan. 1985 218 p
(Contract AF PROJ. 6670)
(AD-A160420; AFGL-TR-85-0012; AFGL-ERP-905) Avail: NTIS HC A10/MF A01 CSCL 17I

Doppler radar and aircraft data acquired during the 1981 and 1982 observation seasons are discussed. Time histories of Doppler radar mean velocity and spectrum variance data acquired while tracking an instrumented aircraft during 34 thunderstorm penetrations are presented. Time histories and analysis of turbulence severity, as determined from these radar and aircraft data, are also presented. Whereas use of radar mean velocity in structure function analysis results in underestimation of the actual turbulence severity, radar methods based upon Doppler spectrum variance successfully detect regions of turbulence hazardous to aircraft. The variance-based method, employing a modeled turbulence energy spectrum with a maximum finite eddy size, is found most effective when the turbulence outer scale lies in the range of 1 to 4 km. Classification of turbulence severity as light, moderate, heavy, or severe with a single outer scale value was unreliable. However, classification into composite severity classes, where a composite class combined two or more individual severity classes, was found to be a successful approach for locating hazardous and nonhazardous turbulence regions. Data also show Doppler spectrum variance to be poorly correlated with shear of the radial wind. This shear, resulting from nonturbulence storm structure generally contributed less than 10% of the turbulence contribution to Doppler spectrum variance and could generally be neglected when estimating turbulence severity. GRA

N86-18933# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Abt. Meteorologische Fernerkundung.
CALCULATION OF ICE ACCRETION ON CYLINDRICAL RODS ACCORDING TO BAIN'S MODEL, AND COMPARISON WITH EXPERIMENTAL RESULTS
W. FUCHS (Geophysikalische Beratungsstelle Roth, West Germany), K. P. SCHICKEL, J. KALUZA (Geophysikalische Beratungsstelle, Cochem, West Germany), and K. UWIRA (Bundesamt fuer Wehrtechnik und Beschaffung, Landsberg/Lech, West Germany) Jul. 1985 81 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-970)
(DFVLR-FB-85-46; ISSN-0171-1342) Avail: NTIS HC A05/MF A01; DFVLR, Cologne DM 25.50

Bain's model for the calculation of ice accretion rates was compared with meteorological flight data. The Bain model for the determination of the ice accretion rate on cylindrical rods is extended to the calculation of the accretion shape and velocity in pure water clouds. Ice accretion is measured on an aircraft during flights in stratus clouds. By taking into account the energy balance estimate of Ludlam for the calculation of an upper bound on the spontaneously freezing supercooled liquid water content (LWC), good agreement between the calculated and measured ice accretion is obtained. The effect of higher LWC's on the ice accretion is not proportional, as theory shows. Author (ESA)

N86-19808# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
WIND SHEAR INVESTIGATION PROGRAM AT THE NLR
H. HAVERDINGS 23 Mar. 1984 52 p refs In DUTCH; ENGLISH summary Presented at Aeronautical Symposium, Delft, Netherlands, 13 Apr. 1984
(NLR-MP-84027-U; B8571447) Avail: NTIS HC A04/MF A01

Wind shear statistics were collected from wide-body aircraft equipped with an airborne integrated data acquisition system during 9000 approaches and landings. In the resulting time dependent wind profiles, wind shear occurrences were analyzed, using a statistical discrete gust method. Flight simulation studies of F-28 aircraft landings for 8 wind profiles with different wind shear types were performed to evaluate 2 wind shear detectors. During the simulation, effort ratings of three pilots for air speed control and tracking the glide path were established. The indication of flight energy deviation is preferred above indication of this magnitude expressed in change of time. Ground and on-board indicators, including apparatus using predictive remote sensing techniques were surveyed. Author (ESA)

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LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

A86-23724
COCKPIT AUTOMATION TECHNOLOGY
A. J. ARETZ (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Human Factors Society, Annual Meeting, 28th, San Antonio, TX, October 22-26, 1984, Proceedings. Volume 1 . Santa Monica, CA, Human Factors Society, 1984, p. 487-491.

This paper presents a prototype methodology conceived by the United States Air Force to establish a baseline approach in the development of a new human factors crew station design methodology for emerging weapon systems. The goal of the project is to develop a structured human factors design methodology that can be used by designers to assess emerging technologies and relate them to system requirements and human performance characteristics so that the features of the resulting designs satisfy specific operational mission objectives. Author

A86-23738
CONCEPT FLYING - A METHOD FOR DERIVING UNIQUE SYSTEM REQUIREMENTS
J. C. SIMONS and S. B. HOTTMAN (Systems Research Laboratories, Inc., Dayton, OH) IN: Human Factors Society, Annual Meeting, 28th, San Antonio, TX, October 22-26, 1984, Proceedings. Volume 2 . Santa Monica, CA, Human Factors Society, 1984, p. 825-828. refs

Simons (1974) discussed an approach to achieving concept breakthroughs by inserting intuitive researchers in loosely structured, scaled-down situations. The approach involves the observation of the pilot when he is interacting in a loosely constrained operational environment. The considered approach, called 'concept flying', represents a technique for the development of new systems designs. Today the main shortfall of concept flying techniques is that they are seldom used. The present paper provides successful concept-flight programs, and new proposals for using concept flying in a study of concepts which are beyond the capabilities of current aircraft. G.R.

A86-25651
NOISE LEVELS IN COCKPITS OF AIRCRAFT DURING NORMAL CRUISE AND CONSIDERATIONS OF AUDITORY RISK
D. C. GASAWAY (Cabot Corp., E-A-R Div., Indianapolis, IN) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 57, Feb. 1986, p. 103-112. refs

Noise data, including A-levels and C-minus-A values, are summarized for exposures associated with normal cruise flight in 13 groups of 593 aircraft; means and standard deviations are reported; degrees of auditory risk using OSHA-1983 criterion are presented; and at-the-ear protected and unprotected exposures are revealed. Mean A-levels were 95.0 for 528 fixed-wing; 100.9 for 65 rotary-wing; and 95.7 for all 593 aircraft. Of 13 subgroups, the lowest mean A-level (85.5) was exhibited in the cockpits of tail-mounted turbojet/fan-powered aircraft, and the highest (105.0) was found in both reciprocating and turbine-powered twin-rotor helicopters. All means A-levels exceeded the OSHA damage-risk criterion for 8 h/d exposures. At-the-ear exposures while wearing hearing protection are presented. Results clearly illustrate the potential for auditory damage of unprotected aircrews. Hearing protection must be considered to effectively control routinely encountered exposures. The material and illustrations resulting from this study will help health and safety monitors during indoctrination and counseling of aircrews concerning the need to protect their hearing against noise exposures during normal and routine flight operations. Author

A86-25652
EFFECT OF SEAT CUSHIONS OF HUMAN RESPONE TO +GZ IMPACT
B. F. HEARON and J. W. BRINKLEY (USAF, Aerospace Medical Research Laboratories, Wright-Patterson AFB, OH) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 57, Feb. 1986, p. 113-121. refs
(Contract F33615-83-C-0500)

Several ejection seat cushions are evaluated based on human response to vertical impact acceleration. The cushions consist of: (1) one layer of 5.1 cm thick low-density conventional polyurethane foam and a second layer of 1.3 cm thick high-density plastic foam (F-111 cushion); (2) a layer of 1 cm thick sheet foam polyethylene, 1.3 cm Temper foam, and 0.6 cm thick space fabric (ACES II cushions); and (3) 5.1 cm thick rate-dependent slow-recovery polyurethane foam. Vertical impact tests were performed on 25 subjects of 26.1 + or - 3.4 years, weighing 79.1 + or - 9.0 kg, and 178 + or - 7.1 cm tall; the test conditions and equipment are described. The carriage acceleration and velocity, seat loads, and head and chest acceleration are measured and compared. The data reveal that the F-111 and ACES II cushions have higher seat loads and head and chest accelerations than the rate-dependent polyurethane foam cushions; it is concluded that the rate-dependent cushions provided greater impact protection than current operational cushions. I.F.

A86-26002
FLIGHT DECK AUTOMATION DECISIONS
E. F. WEENER (Boeing Commercial Airplane Co., Seattle, WA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 3-8. refs
(SAE PAPER 841471)

Effective man-machine interface design for an airplane flight deck depends strongly on providing apppropriate levels of control capability for use by the flight crew. The range of control options available to the airplane system designer extends from manual through partially automatic to full automatic. Selection of appropriate types and levels of automation for each new airplane is a complex task. It involves understanding the capabilities and limitations of the human operator, airplane operational and functional considerations, as well as concerns for cost and available technology. Recent airplanes have demonstrated the practicality of providing different levels of automation which can be applied by the flight crew under different circumstances. This trend expands the options available to the flight crew in coping with the changing operational environment. It also allows the flight crew to participate directly in the choice of when and how to apply automation. This paper describes the various automation factors which are considered in the process of developing a design. Author

A86-26003
FLIGHT DECK DESIGN METHODOLOGY USING COMPUTERIZED ANTHROPOMETRIC MODELS
G. STONE and H. MCCAULEY (Douglas Aircraft Co., Long Beach, CA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 9-16. refs
(SAE PAPER 841472)

A new 'inside out' flight deck design methodology has been developed, in which the flight crew member is the logical starting point. Several computer models that simulate varying pilot sizes, proportions, reach, and vision capabilities are created and utilized to generate the required 'envelopes' of vision, reach, and motion for the entire range of the pilot population. These envelopes are then employed to define the internal geometric relationships of the flight deck and its components. The methodology is described, including discussions of the aspects of defining the user population, generation of crew sample, creating a three-dimensional operator model, determining functional envelopes, and component integration. Design diagrams are included. I.S.

A86-26004

AI APPLICATIONS TO MILITARY PILOT DECISION AIDING - A PERSPECTIVE ON TRANSITION

W. G. JAMES (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 19-24.
(SAE PAPER 841533)

The process of transition of the Pilot Decision Aiding AI technology to operational application is discussed in the framework of various R&D programs. The experience of implementing the 'intent-driven' cockpit technology in a Coast Guard helicopter and in simulation and flight test programs is described. A priority list of the subsystems and activities sufficiently mature for early automation and decision aiding is given, and the three consecutive steps to be taken for the transition ('Imitate', 'Embellish', and 'Fully Exploit') are explained. The importance of an airborne development program that precedes the flight evaluation program is emphasized. I.S.

A86-26005

AUTOMATION IN THE COCKPIT - WHO'S IN CHARGE?

R. W. MOSS, J. M. REISING, and N. R. HUDSON (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 25-29. refs
(SAE PAPER 841534)

This paper discusses levels of automation and decision making and arrives at an overall design philosophy for allocating tasks to the pilot and the computer. In order to produce a levels of automation matrix three categories of pilot-computer interface (pilot only, blended, and computer only) and three types of goals, (mission, functional and task), are identified. These two dimensions are then used to create a matrix which can be employed as a means of comparing automated systems. The options that the matrix produces are discussed and examples given. The overall design philosophy is to have the mission goals accomplished in a blended manner with both the pilot and computer contributing. Lower level goals are handled exclusively by the computer. The reasoning for this philosophy is to allow the pilot to operate in a rule-based environment so that he can optimally cope with the greatly increased amounts of information he will face in future missions. Author

A86-26009

EFFECT OF VIBRATION ON THE READABILITY OF COLOR CRT DISPLAYS

L. IVEY (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 53-59. refs
(SAE PAPER 841466)

The readability of symbols on a color CRT display in a vibrational environment equivalent to low-level flights was rated by eight aircraft personnel subjects undergoing tests in a Sixmode motion simulator. The differences in the values of the chrominance and luminance between static and vibrational conditions were determined. In addition, the impact of wearing protective PLZT goggles was evaluated. The comfortable viewing zone for the normal (non-PLZT) case was between 2.5 and 6.5 Hz, whereas the zone with PLZT was between 3 and 6.5 Hz. The colors and symbol changes caused by the applied vibration were acceptable, indicating the stability of the Sperry CRT shadow mask. The legibility data indicate that in a vibration environment, a minimum symbol size of greater than 0.12 in. is necessary. The digital update rate change should be between 3 and 5 Hz for the most comfortable viewing and the least errors. I.S.

A86-26016

A REVIEW OF PILOT WORKLOAD MEASUREMENT TECHNIQUES USED ON THE A-10 SINGLE SEAT NIGHT ATTACK TEST PROGRAM

C. D. CRITES (USAF, Human Factors Branch, Edwards AFB, CA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 107-112.
(SAE PAPER 841492)

A three-phase flight test program to evaluate the A-10 Single Seat Night Attack (SSNA) aircraft was conducted at the Air Force Flight Test Center (AFFTC), Edwards AFB, CA. An important objective of the SSNA testing was to assess, and where possible, measure pilot workload. The techniques utilized during the test program to quantify workload were: an objective measurement of task performance, control activity, and physiological status data, and the Subjective Workload Assessment Technique (SWAT). The use of objective techniques represented the first application in a flight test environment and an initial attempt to validate their use as work-load metrics. Both objective and subjective methods were of significant value, but both techniques had limitations and shortfalls. Lessons learned affecting the application of the techniques to on-going and future flight test programs are described. Author

A86-26018

ADVANCED FIGHTER TECHNOLOGY INTEGRATION (AFTI) F-16 - THE PILOT INTERFACE

D. R. MCMONAGLE (USAF, Flight Test Center, Edwards AFB, CA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 121-125.
(SAE PAPER 841633)

The aspects of the pilot-vehicle interphase in the two first phases of the Advanced Fighter Technology Integration (AFTI)/F-16 Program, which was designed to develop and demonstrate technologies and alternatives for future fighter aircraft design, are discussed. The results of the first AFTI phase, the Digital Flight Control System, indicated the need for multiple flight control mode capability in future multirole fighter aircraft. The second phase of the Program, the Automated Maneuvering Attack System, which began in July 1984, involves the development and evaluation of improved sensors, integrated fire and flight control for automated maneuvering weapon delivery, and enhancements in pilot-vehicle interface. I.S.

A86-26019* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFECTS OF DIGITAL ALTIMETRY ON PILOT WORKLOAD

R. L. HARRIS, SR. (NASA, Langley Research Center, Hampton, VA) and B. J. GLOVER (Kentron International, Inc., Hampton, VA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 131-136. Previously announced in STAR as N86-13892.
(SAE PAPER 841489)

A series of VOR-DME instrument landing approaches was flown in the DC-9 full-workload simulator to compare pilot performance, scan behavior, and workload when using a computer-drum-pointer altimeter (CDPA) and a digital altimeter (DA). Six pilots executed two sets of instrument landing approaches, with a CDPA on one set and a DA on the other set. Pilot scanning parameters, flight performance, and subjective opinion data were evaluated. It is found that the processes of gathering information from the CDPA and the DA are different. The DA requires a higher mental workload than the CDPA for a VOR-DME type landing approach. Mental processing of altitude information after transitioning back to the attitude indicator is more evident with the DA than with the CDPA. E.A.K.

A86-26022

WINGING IT IN THE 1980'S - WHY GUIDELINES ARE NEEDED FOR COCKPIT AUTOMATION

M. R. HOAGLAND (Air Line Pilots Association, International, Washington, DC) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, *Proceedings* . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 155-162. refs
(SAE PAPER 841634)

There have been many reasons for the introduction of automation into the cockpit of the modern airliner. In some cases the forces driving technology have caused the design of automated systems which compromise the ability of the pilot to fulfill his responsibilities for the safety of the airplane under his command. This paper examines how these forces can lead to unnecessary cockpit automation, and discusses what must be done to avoid the introduction of automated systems which have the effect of removing the human operator from the information and control processes. Author

A86-26023

SITUATION VERSUS COMMAND

J. G. OLIVER (Air Line Pilots Association, International, Washington, DC) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 163-165.
(SAE PAPER 841638)

Two types of flight information are provided to pilots, situational and command. Situation information tells the pilot the state of the aircraft and its flight path while command information tells the pilot what to do and is not related to any given situation. This paper discusses why it is extremely important for the pilot to be provided with appropriate and adequate situation information in all aircraft but especially in modern highly-automated aircraft. Author

A86-26024

THE DECISION TO FLY

A. F. ZELLER IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 169-176.
(SAE PAPER 841613)

The decision to fly and the capacity to carry a flight to a successful termination involves a wide spectrum of background determinants. These range from considerations of the pilot as a physical being with specific potentials and limitations of body structure, mental ability and emotional capacities to the adequacy of learning related to a specific performance and the character and condition of the aircraft. Specific factors relevant to each of these categories is discussed including the psycho-social, physiological and pathological. Crucial to success is the pilot's self-critical judgement. There is a necessary tension between the ongoing activity of carrying out a positive decision to fly and the requirements for continual assessment of the situation. Author

A86-26028

U.S. ARMY HELICOPTER *VOICE* TECHNOLOGY APPLICATIONS

F. J. MALKIN (U.S. Army, Human Engineering Laboratory, Aberdeen Proving Ground, MD) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 207-211. refs
(SAE PAPER 841609)

Voice technology provides a potential for alleviating the extremely high visual and manual workload of Army helicopter pilots. Before voice technology can be successfully employed in the cockpit, there are many human factors issues that must be resolved. This paper describes the approach used to identify potential applications of voice technology in an Army helicopter and the emulation of a voice interactive Doppler navigation set. Author

A86-26030* Psycho-Linguistic Research Associates, Menlo Park, Calif.

COMPARISON OF VOICE TYPES FOR HELICOPTER VOICE WARNING SYSTEMS

C. A. SIMPSON, K. MARCHIONDA-FROST, and T. NAVARRO (Psycho-Linguistic Research Associates, Menlo Park, CA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 217-224. Army-supported research. refs
(Contract NAS2-11341)
(SAE PAPER 841611)

Three related studies were conducted to compare different types of human voice warnings. In the first study, a comparison of three LPC-encoded voices, human female, human male, and phoneme-synthesized, by the criteria of pilot flight task performance showed no differences due to the voice type. In the second study, pilots' preferences were investigated, by comparing preference for direct synthesized speech to the LPC-encoded human female speech and to LPC-encoded synthesized speech. Most pilots were found to prefer direct synthesized speech over both LPC-encoded *human female speech and the LPC-encoded synthesized speech.* In the third study, phonetically balanced (PB) words heard in simulated helicopter noise were used to compare the intelligibility of direct synthesized and LPC-encoded phoneme-synthesized speech types. PB word intelligibility was found to be better for direct synthesized speech than for the LPC-encodes synthesized speech. I.S.

A86-26031

ADVANCED TECHNOLOGY - NEW FIXES OR NEW PROBLEMS?

C. A. SIMPSON (Psycho-Linguistic Research Associates, Menlo Park, CA) IN: Aerospace Behavioral Engineering Technology Conference, 3rd, Long Beach, CA, October 15-18, 1984, Proceedings . Warrendale, PA, Society of Automotive Engineers, Inc., 1984, p. 225-236. refs

The principles of application of voice technology to cockpit control and display systems, the advantages of its use and the *pitfalls of its misuse or overuse are discussed.* The omnidirectionality and the sequential nature of speech imply the general requirements of short sentences, the minimal number of multiple messages, and avoidance of concurrent messages in the use of voice for both display and command purposes. To be of an advantage to the pilot, the use of voice displays must be limited to time-critical flight information, and the use of voice control must be limited to time-critical operations, both at the time when the pilot is visually or manually occupied to the extent that the voice display/command will reduce his workload. Especially important will be an integrated design of all voice controls and displays in order to avoid overloading the pilot with multiple messages and required control inputs, in a transmission mode that is essentially a single-channel system. I.S.

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A86-23263
FLIGHT TEST DATA ACQUISITION AND PROCESSING SYSTEM
B. J. FISTER (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 12-1 to 12-10.

The development of a modern and effective data acquisition and processing system for flight testing commercial aircraft engines is discussed. The specifications and required accuracy of the system are presented, and the various aspects of the data acquisition system are examined, including the input, block design, block temperature determination, analog multiplexer, pressure system, calibration, transducers, frequency measurement, and output. A system block description is given, and the ground station and calibration are described. The system's two main operating modes for acquiring data, a steady state mode and a transient mode, are addressed. The software data flow is shown and described, and present operating experience is reported. C.D.

A86-23264
A STUDY OF STATE OF THE ART COMPUTER GRAPHICS SYSTEMS FOR FLIGHT SAFETY MONITORING
D. J. MALONE (Computer Sciences Corp., Systems Div., Lompoc, CA) and M. SHRADER-FRECHETTE (Florida, University, Gainesville) IN: Society of Flight Test Engineers, Annual Symposium, 15th, St. Louis, MO, August 12-16, 1984, Proceedings . Lancaster, CA, Society of Flight Test Engineers, 1984, p. 13-1 to 13-14. refs

The state of the art in high-speeds, high-resolution, computer-driven, color-graphic display systems suitable for the growth of a currently in-place but obsolescent systems is studied. Potential deficiencies of present systems in the areas of quality of the display image and saturation of the host or display processors are discussed. Currently available graphic display system technologies are examined, including display screen technologies, display controllers, and graphics processors. Needed display features are determined, readily available components which have the required features are identified, and recent technological advances are extrapolated in order to identify future developments. C.D.

A86-23343
DYNAMIC SYSTEMS: MODELLING AND CONTROL; PROCEEDINGS OF THE WINTER ANNUAL MEETING, MIAMI BEACH, FL, NOVEMBER 17-22, 1985
M. DONATH, ED. (Minnesota, University, Minneapolis) Meeting sponsored by ASME. New York, American Society of Mechanical Engineers (Dynamic Systems and Control Symposia Series. DSC Volume 1), 1985, 351 p. .

Various papers on system dynamics and its control are presented. The general topics discussed include: adaptive control, systems modelling and control, fluid control systems, system identification theory and its applications, strategies for control system design, dynamics and control of thermofluid design, and vehicle system dynamics. Some of the individual papers address: nonlinear control of a distributed system, stability study of vortex amplifier distributed circuits, stable discrete-time adaptive observer applied to multivariable aircraft, reduction of discrete multivariable systems by stochastic approximations, parameter identification by robot control, and decoupling in distributed control system through error compensation. C.D.

A86-23581
OPTIMAL CONTROL OF INTEGRAL-FUNCTIONAL EQUATIONS [OB OPTIMAL'NOM UPRAVLENII INTEGRAL'NO-FUNKTSIONAL'NYMI URAVNENIIAMI]
L. E. SHAIKHET Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 49, Nov.-Dec. 1985, p. 923-934. In Russian. refs

The optimal control of a stochastic integral-functional equation of neutral type with an integral quality functional is examined. The necessary condition of control optimality is established. An explicit form of optimal control is obtained in the case of a linear quadratic problem. B.J.

A86-23708
A STUDY OF PROGRAMMABLE SWITCH SYMBOLOGY
J. S. HAWKINS, J. M. REISING, B. K. WOODSON (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), and S. J. BERTLING (U.S. Air Force Academy, Colorado Springs, CO) IN: Human Factors Society, Annual Meeting, 28th, San Antonio, TX, October 22-26, 1984, Proceedings. Volume 1 . Santa Monica, CA, Human Factors Society, 1984, p. 118-122. refs

A multifunction switch is one way to solve the diminishing real estate problem in the modern cockpit. This study looked at pictorial coding of such a switch. Twelve different symbols were used, each with three levels of complexity and two levels of polarity. An error rate count was taken for subjects under both a naive and learned 50 millisecond exposure condition. This study demonstrated that there were three classes of symbols. These were: intuitive to the naive subject, intuitive to a learned subject, and nonintuitive, even to a learned subject. Complexity levels had a significant effect in only three of the twelve symbols. Polarity differences also had a significant effect in only three of the twelve symbols, although they were a different three. The overall conclusion is that the majority of symbols were intuitive after learning and robust to changes in complexity and polarity. Author

A86-24586
OPTIMIZATION OF STEPPED INPUT SIGNALS IN THE FREQUENCY DOMAIN FOR PARAMETRIC IDENTIFICATION [OPTIMIERUNG STUFENFOERMIGER EINGANGSSIGNALE IM FREQUENZBEREICH FUER DIE PARAMETERIDENTIFIZIERUNG]
K.-O. PROSKAWETZ (Braunschweig, Technische Universitaet, Brunswick, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 9, Nov.-Dec. 1985, p. 362-370. In German. refs

For parameter determination in dynamic systems, optimized input signals with energy density spectra of desired shape and energy density level are required. Mathematical relationships for optimizing stepped input signals with respect to their energy density spectra are presented, and the influence of control parameters is discussed. Some optimized, stepped input signals and their energy density spectra are presented along with their application to parameter estimation in a simulated aircraft model. C.D.

A86-25035* California Univ., Davis.
AUTOMATION EFFECTS IN A MULTILOOP MANUAL CONTROL SYSTEM
R. A. HESS and B. D. MCNALLY (California, University, Davis) IEEE Transactions on Systems, Man, and Cybernetics (ISSN 0018-9472), vol. SMC-16, Jan.-Feb. 1986, p. 111-121. refs (Contract NAG2-221)

An experimental and analytical study was undertaken to investigate human interaction with a simple multiloop manual control system in which the human's activity was systematically varied by changing the level of automation. The system simulated was the longitudinal dynamics of a hovering helicopter. The automation-systems-stabilized vehicle responses from attitude to velocity to position and also provided for display automation in the form of a flight director. The control-loop structure resulting

from the task definition can be considered a simple stereotype of a hierarchical control system. The experimental study was complemented by an analytical modeling effort which utilized simple crossover models of the human operator. It was shown that such models can be extended to the description of multiloop tasks involving preview and precognitive human operator behavior. The existence of time optimal manual control behavior was established for these tasks and the role which internal models may play in establishing human-machine performance was discussed. Author

A86-26118#
THE DEVELOPMENT AND APPLICATION OF FINITE ELEMENT STRESS ANALYSIS TECHNIQUES AT WESTLAND HELICOPTERS LTD
M. L. W. SALZER and P. C. WOOD (Westland, PLC, Helicopter and Hovercraft Group, Yeovil, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 22 p.

This paper discusses the role of the finite element method in the design-development cycle. No attempt is made to give a theoretical background but rather to outline the technique, method of implementation and areas of application. In particular the pre- and post-processing software package WISDOM is examined and the steps involved in performing a finite element statics analysis. It is envisaged that with more powerful computers and the acceptance of CAD solid modelling in design, that the time required to perform a finite element analysis will be reduced even further. Some of the improvements that are required to achieve this time reduction are also discussed. Author

A86-26166#
DEVELOPMENT TESTING OF INTEGRATED AVIONICS SYSTEMS USING DYNAMIC ENVIRONMENT SIMULATION
P. L. SHILLITO (Westland Helicopters, Ltd., Yeovil, England) Netherlands Association of Aeronautical Engineers and Technische Hogeschool te Delft, European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug. 28-31, 1984, Paper. 21 p. refs

The evolution of sophisticated integrated avionics packages and their incorporation into civil and military helicopters has caused and will continue to cause significant perturbations to avionics and airframe manufacturers' integration plans. A coherent testing philosophy is discussed which co-ordinates avionic system design with its supporting development and validation tools. Highlighted is the use of inherent system performance data to maintain, system integrity during validation of the developed system core whilst permitting full test automation. Facilities developed for dynamic simulation and performance assessment and presentation are described. These techniques are shown to reduce costs, improve effectiveness, and provide a high demonstrable level of confidence in the resultant integrated system. Author

N86-19008*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PARTITIONING AND PACKING MATHEMATICAL SIMULATION MODELS FOR CALCULATION ON PARALLEL COMPUTERS
D. J. ARPASI and E. J. MILNER 1986 38 p refs Prepared for Presentation at the 1986 International Conference on Parallel Processing, St. Charles, Ill., 19-22 Aug. 1986; sponsored by Pennsylvania State Univ. and IEEE Computer Society
(NASA-TM-87170; E-2808; NAS 1.15:87170) Avail: NTIS HC A03/MF A01 CSCL 09B

The development of multiprocessor simulations from a serial set of ordinary differential equations describing a physical system is described. Degrees of parallelism (i.e., coupling between the equations) and their impact on parallel processing are discussed. The problem of identifying computational parallelism within sets of closely coupled equations that require the exchange of current values of variables is described. A technique is presented for identifying this parallelism and for partitioning the equations for parallel solution on a multiprocessor. An algorithm which packs the equations into a minimum number of processors is also described. The results of the packing algorithm when applied to a turbojet engine model are presented in terms of processor utilization. Author

N86-19045# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
AN INTRODUCTION TO THE APPLICATION OF COMPUTER AIDED DESIGN (CAD) TO THE PREDESIGN OF AIRCRAFT AND THE DESIGN OF AIRCRAFT STRUCTURES AT THE AEROSPACE SECTION [EEN INTRODUKTIE TOT DE TOEPASSING VAN CAD IN HET VOORONTWERPEN VAN VLIEGTUIGEN EN HET ONTWERPEN VAN VLIEGTUIGKONSTRUKTIES AAN DE AFDELING DER LUCHTVAART- EN RUIMTEVAARTTECHNIEK]
C. BIL and A. ROTHWELL Mar. 1984 31 p refs In DUTCH (VTH-M-512) Avail: NTIS HC A03/MF A01

Equipment and software of a CAD plant are described and research in aircraft and aircraft structures design is surveyed. Possibilities to integrate an aircraft design and analysis system, the graphical design system MEDUSA, and GIFTS, a program generating calculation models from drawings of existing structures, are outlined. The aim is to create a pilot design system comparable with industrial CAD activities in the preconceptual phase. Author (ESA)

N86-19634# Royal Signals and Radar Establishment, Malvern (England). Integrated Air Defence Systems Div.
APPLICATIONS OF EXPERT SYSTEMS
P. R. WETHERALL *In* AGARD Artificial Intelligence and Robotics 17 p Sep. 1985 refs
Avail: NTIS HC A07/MF A01

An Expert System contains a knowledge base, an inference engine, an explanation system, a model of the real world and a man machine interface. The types of reasoning include interpretation, monitoring, prediction and design, together with specializations of these, such as diagnosis and planning, and aggregations, such as debugging, instruction and control. A range of possible applications are described to illustrate these general tasks. The nature of the knowledge available, and some implementation problems, are identified. The applications include examples in the area of tactical decision aids, specifically sensor data interpretation, data fusion, threat assessment and resource allocation. Other topics include cockpit environments and intelligent tutoring. Finally, some of the problems that limit the immediate widespread adoption of the technology are discussed. Author

N86-19968*# Computer Sciences Corp., Silver Spring, Md.
AN APPROACH TO DEVELOPING SPECIFICATION MEASURES
W. W. AGRESTI *In* NASA. Goddard Space Flight Center Proceedings of the Ninth Annual Software Engineering Workshop p 14-41 Nov. 1984 refs
Avail: NTIS HC A16/MF A01

An approach to developing specification measures is described. A key feature of the approach is the introduction of a new requirements representation, the Composite Specification Model (CSM). Results are reported from an experiment in which the requirements for a real system are recast using the CSM. Specification measures are then extracted from the CSM representation of the system. Author

N86-20006# Air Force Armament Lab., Eglin AFB, Fla.
MELLIN-FOURIER CORRELATION Final Technical Report, Jun. 1982 - Jan. 1984
E. C. FRIDAY Aug. 1985 53 p
(Contract AF PROJ. 230-5)
(AD-A159685; AD-E801193; AFATL-TR-85-53) Avail: NTIS HC A04/MF A01 CSCL 05H

This program evaluates the success of a pattern recognition system which attempts to recognize an object even though the object differs in size and orientation from the object used as a reference. The criteria for recognition were the peak value and shape of the cross correlation function calculated in two dimensions. The cross correlation was performed using Fourier

transform techniques to judge the utility of implementing the system using many standards optical components. Size, or scale, invariance was achieved using a logarithmic sampling technique (the Mellin transform), and variations on traditional sampling methods were shown to extend the scale invariance predicted by various researchers. The utility of the sampling techniques developed was proven using images acquired from infrared sensors carried aboard helicopters. Limits of practical scale invariance were explored and system design approaches were suggested from the results of numerical experiments carried out in computer simulations. GRA

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A86-23134*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AIRFOIL TIP VORTEX FORMATION NOISE
T. F. BROOKS and M. A. MARCOLINI (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 24, Feb. 1986, p. 246-252. Previously cited in issue 01, p. 73, Accession no. A85-10859. refs

A86-23576
LIAPUNOV FUNCTION FOR STUDYING THE STABILITY IN THE WHOLE OF NONLINEAR SYSTEMS [FUNKTSII LIAPUNOVA DLIA ISSLEDOVANIIA USTOICHIVOSTI V TSELOM NELINEINYKH SISTEM]
A. B. AMINOV and T. K. SIRAZETDINOV Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 49, Nov.-Dec. 1985, p. 883-893. In Russian. refs

Sufficient conditions are obtained for the sign-determinacy of a sum of polylinear forms. These sums are used to form Liapunov functions which are employed to derive sufficient conditions for the asymptotic stability in the whole of the unperturbed motion of nonlinear systems. The perturbed motions are described by a set of ordinary differential equations with a right part in the form of a sum of homogeneous polynomials. The proposed approach is applied to the analysis of the longitudinal stability of an aircraft with allowance for the nonlinearity of the aerodynamic coefficients and nonlinear relations between the angle of attack and the pitch angle. B.J.

A86-23674
LONGITUDINAL POTENTIAL DISTRIBUTION IN A JET OF AN IONIZED GAS [PRODOL'NOE RASPREDELENIE POTENTSIALA V REAKTIVNOI STRUE IONIZOVANNOGO GAZA]
N. M. PISAREV, IU. P. STAVROV, and V. I. TAMBOVTSEV Aviatsionnaia Tekhnika (ISSN 0579-2975), no. 3, 1985, p. 99, 100. In Russian.

The effect of longitudinal potential distribution in stationary jets of an ionized gas, such as those produced by jet aircraft, is investigated experimentally for the case where a jet of an ionized gas issues from an axisymmetric conical nozzle into a space flooded with a neutral gas. An expression is obtained for the longitudinal potential distribution for the main section of a jet relative to its source for quasi-neutral conditions. The validity of the expression is verified experimentally for a jet engine with a thrust of 230 N and a discharge velocity of 1800 m/s. V.L.

A86-25217#
RESEARCH ON SONIC INLET
R. SASAKI, Y. KOHAYAGAWA, K. HIRAOKA, and T. WATANABE Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 378, 1985, p. 420-432. In Japanese, with abstract in English.

In recent aircraft with high by-pass ratio engines, the major noise source is the forward propagating fan noise from the engine inlet. Reported here is the investigation of the sonic inlet, which drastically reduces the abovementioned forward propagating fan noise. Model sonic inlets of both contracting wall type and translating centerbody type were designed by a newly developed analytical method based on flux analysis, and tested aerodynamically and acoustically. Criteria for boundary layer separation, total pressure recovery characteristics, and crosswind characteristics of a sonic inlet were obtained, and a model sonic inlet of the contracting wall type showed 21 PNdB noise reduction in model engine noise tests. Comparison between the analytical and experimental results proved the usefulness of the newly developed design method. Author

N86-19123 New South Wales Univ., Kensington (Australia).
HIGH VELOCITY GAS JET NOISE CONTROL Abstract Only
A. DAY 1985 3 p
Avail: Issuing Activity

The physics of jet noise generation, and some of the principal applications and methods of jet noise control are described. Jet noise generation due to the nozzle size, discharge velocity, gas density, jet shape, etc., is well documented by scientific literature, complete with mathematical formulae for noise level prediction. Worked examples are provided. G.L.C.

N86-19125*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LABORATORY EXPERIMENTS ON ACTIVE SUPPRESSION OF ADVANCED TURBOPROP NOISE
J. H. DITTMAR Dec. 1985 18 p refs
(NASA-TM-87129; E-2740; NAS 1.15:87129) Avail: NTIS HC A02/MF A01 CSCL 20A

The noise generated by supersonic tip speed propellers may be a cabin environment problem for future propeller-driven airplanes. Active suppression from speakers inside the airplane cabin has been proposed for canceling out this noise. The potential of active suppression of advanced turboprop noise was tested by using speakers in a rectangular duct. Experiments were first performed with sine wave signals. The results compared well with the ideal cancellation curve of noise as a function of phase angle. Recorded noise signals from subsonic and supersonic tip speed propellers were than used in the duct to deterthe potential for canceling their noise. The subsonic propeller data showed significant cancellations but less than those obtained with the sine wave. The blade-passing-tone cancellation curve for the supersonic propeller was very similar to the subsonic curve, indicating that it is potentially just as easy to cancel supersonic as subsonic propeller blade-passing-tone noise. Propeller duct data from a recorded propeller source and spatial data taken on a propeller-drive airplane showed generally good agreement when compared versus phase angle. This agreement, combined with the similarity of the subsonic and supersonic duct propeller data, indicates that the area of cancellation for advanced supersonic propellers will be similar to that measured on the airplane. Since the area of cancellation on the airplane was small, a method for improving the active noise suppression by using outside speakers is discussed. Author

N86-19127# Federal Aviation Administration, Washington, D.C. Office of Environment and Energy.
FLIGHT OPERATIONS NOISE TESTS OF EIGHT HELICOPTERS
S. A. YOSHIKAMI Aug. 1985 697 p
(AD-A159835; FAA/EE-85-7) Avail: NTIS HC A99/MF A02 CSCL 01C

This document presents acoustical data and flight path information acquired during the FAA/HAI Helicopter Flight

Operations Noise Test Program. As-measured noise levels of the Aerospatiale 365N, Agusta 109A, Bell 206L-1 and 222A, Hughes 500D, MBB BK117, Robinson R22, and Sikorsky S76 are presented for various enroute and heliport flight operations. These operations include level flyovers at two altitudes, normal takeoffs, normal and constant-glideslope approaches, various types of noise abatement approaches, level flight turns and hover (IGE and OGE). The acoustical data are accompanied by radar tracking data and cockpit instrument panel information which document the operational procedures flown, and meteorological measurements to permit data corrections for nonstandard atmospheric conditions. This helicopter operational noise data base can be used in enroute and heliport land use planning, heliport environmental studies and planning guidelines, pilot familiarization and training, verification of noise prediction and estimating methods, and lateral attenuation studies. GRA

N86-19136# Massachusetts Inst. of Tech., Lexington.
DISTRIBUTED SENSOR NETWORKS Semiannual Technical Summary Report, 1 Oct. 1984 - 31 Mar. 1985
R. T. LACOSS 26 Sep. 1985 32 p
(Contract F19628-85-C-0002; ARPA ORDER 3345; AF PROJ. 5D30; AF PROJ. 5T10)
(AD-A160596; ESD-TR-85237) Avail: NTIS HC A03/MF A01 CSCL 17B

The Distributed Sensor Networks (DSN) program is aimed at developing and extending target surveillance and tracking technology in systems that employ multiple spatially distributed sensors and processing resources. Such a system would be made up of sensors, data bases, and processors distributed throughout an area and interconnected by an appropriate digital data communication system. The detection, tracking, and classification of low flying aircraft has been selected to develop and evaluate DSN concepts in the light of a specific system problem. A DSN test bed has been developed and is being used to test and demonstrate DSN techniques and technology. The overall concept calls for a mix of sensor types. The initial test-bed sensors are small arrays of microphones at each node augmented by TV sensors at some nodes. This Semiannual Technical Summary (SATS) reports results for the period 1 October 1984 through 31 March 1985. Progress in the development of distributed tracking algorithms and their implementation in the DSN test-bed system is reviewed in Section II. Test-bed versions of distributed acoustic tracking algorithms now have been implemented and tested using simulated acoustic data. This required developing a solution to a basic distributed tracking problem: the information feedback problem. Target tracks received by one node from another node often implicitly include information that originally was obtained from the receiving node. GRA

N86-19143# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
REPORT OF NOISE MEASUREMENTS WITH 2 DIFFERENT MICROPHONE DISPOSITIONS ON AIRPLANE TYPE CESSNA F 172L [VERSLAG VAN GELUIDSMETINGEN MET TWEE VERSCHILLENDE MICROFOONOPSTELLINGEN AAN HET VLIEGTUIGTYPE CESSNA F 172L]
D. M. VANPAASSEN Apr. 1984 28 p refs In DUTCH
(VTH-M-510) Avail: NTIS HC A03/MF A01

The noise level of a Cessna F 172L in stationary symmetric horizontal engine flight at 1000 feet height was measured 14 times using 2 microphones placed above a white-sprayed aluminum plate and 1.2 m height above grassland, both horizontally directed to the arriving airplane. The measurements were carried out to determine the variation in noise certification measurements, and to verify a model for the determination of ground impact. The A-weighted noise spectra levels of the plane in overhead position are measured and averaged after flight height deviation corrections. Author (ESA)

N86-20086*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ACOUSTIC GUIDE FOR NOISE TRANSMISSION TESTING OF AIRCRAFT Patent Application
R. VAICAITIS, inventor (to NASA) (Columbia Univ., N.Y., N.Y.) 3 Jul. 1985 13 p Sponsored by NASA
(NASA-CASE-LAR-13111-1-CU; NAS 1.71:LAR-13111-1-CU; US-PATENT-APPL-SN-751695) Avail: NTIS HC A02/MF A01 CSCL 20A

Selective testing of aircraft or other vehicular components without requiring disassembly of the vehicle or components was accomplished by using a portable guide apparatus. The device consists of a broadband noise source, a guide to direct the acoustic energy, soft sealing insulation to seal the guide to the noise source and to the vehicle component, and noise measurement microphones, both outside the vehicle at the acoustic guide output and inside the vehicle to receive attenuated sound. By directing acoustic energy only to selected components of a vehicle via the acoustic guide, it is possible to test a specific component, such as a door or window, without picking up extraneous noise which which may be transmitted to the vehicle interior through other components or structure. This effect is achieved because no acoustic energy strikes the vehicle exterior except at the selected component. Also, since the test component remains attached to the vehicle, component dynamics with vehicle frame are not altered. NASA

N86-20088*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STATUS AND CAPABILITIES OF SONIC BOOM SIMULATORS
K. P. SHEPHERD and C. A. POWELL Jan. 1986 8 p refs
(NASA-TM-87664; NAS 1.15:87664) Avail: NTIS HC A02/MF A01 CSCL 20A

The current status and capabilities of sonic boom simulators which might be used in future studies of the effects of sonic boom on people, animals, or structures is summarized. The list of candidate simulators is based on a literature search which was confined to the United States and Canada. Some of the simulators are fully operational, others could be made operational with a modest investment, and still others would require a major investment. For the sake of the completeness, some simulators which were the subject of a previous review, but which no longer exist, are also included herein. Author

N86-20089*# Bolt, Beranek, and Newman, Inc., Canoga Park, Calif.
IN-FLIGHT ACOUSTIC MEASUREMENTS ON A LIGHT TWIN-ENGINED TURBOPROP AIRPLANE Final Report
J. F. WILBY, C. D. MCDANIEL, and E. G. WILBY Nov. 1985 233 p refs
(Contract NAS1-16521)
(NASA-CR-178004; NAS 1.26:178004) Avail: NTIS HC A11/MF A01 CSCL 20A

Four series of flight tests were conducted to measure sound pressure levels inside and outside the cabin of a twin-engined turboprop airplane. Particular emphasis was placed on harmonics of the propeller blade passage frequency. The cabin was unfurnished for the first three flights, when the main objective was to investigate the repeatability of the data. For the fourth flight, the cabin was treated with fiberglass batts. Typically, the exterior sound pressure levels were found to vary 3 to 5 dB for a given harmonic, but variations as high as 8 dB were observed. The variability of harmonic levels within the cabin was slightly higher but depended on control of the relative phase between the propellers; when phase was not controlled the average variability was about 10 dB. Noise reductions provided by the fuselage structure were in the range of 20 to 40 dB, when an exterior microphone in the plane of rotation of the propeller was used as reference. Author

N86-20090# Federal Aviation Administration, Washington, D.C. Office of Environment and Energy.
INTERNATIONAL CIVIL AVIATION ORGANIZATION HELICOPTER NOISE MEASUREMENT REPEATABILITY PROGRAM: US TEST REPORT, BELL 206L-1, NOISE MEASUREMENT FLIGHT TEST
J. S. NEWMAN, E. J. RICKLEY, and M. LOCKE Sep. 1985 427 p
(AD-A159898; FAA/EE-85-6) Avail: NTIS HC A19/MF A01 CSCL 14B

This document reports the findings of the U.S test team's participation in the Helicopter Noise Measurement Repeatibility Program (HNMRP). The U.S./Canadian flight test was held in August of 1984 at Dulles International Airport near Washington, D.C. The principal objective of this international HNMRP is to refine noise certification testing requirements. Participating nations conducted the test programs on the same type helicopter, the Bell 206L-1 (or the acoustically equivalent 206L-3), using the same test procedures. Analyses in this document include the investigation of source noise adjustments based on increases in noise level with advancing blade tip Mach number, the examination of relative source contributions in the helicopter acoustical spectrum, and source directivity for both in-flight and static operations. This report contains helicopter noise definition information (useful in environmental impact analyses) for level flyovers at various airspeeds and altitudes, and ICAO takeoff and approach procedures. Data are also shown for a noise abatement operation involving dynamic changes in torque, rate of descent and airspeed. This report also provides information for the hover-in-ground effect, flight idle and ground idle static operations. GRA

N86-20094# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
B-52G CREW NOISE EXPOSURE STUDY
W. H. DECKER and C. W. NIXON 30 Aug. 1985 49 p
(Contract AF PROJ. 7231)
(AD-A161112; AFAMRL-TR-85-056) Avail: NTIS HC A03/MF A01 CSCL 20A

The B-52G aircraft produces acoustic environments that are potentially hazardous, interfere with voice communications and may degrade task performance. Numerous reports from aircrew of high noise levels at crew location have been documented for those B-52G aircraft that have been modified with the Offensive Avionics System. To alleviate and minimize the excessive noise exposures of aircrews, a study of the noise problem in the b-52G was deemed necessary. First, in-flight noise measurements were obtained at key personnel locations on a B-52G during a typical training mission. Then, extensive laboratory analyses were conducted on these in-flight noise data. The resulting noise exposure data were evaluated in terms of the various segments of and the total flight profile relative to allowable noise exposures. Finally, recommendations were developed for short term and long term approaches toward potential improvement in the B-52G noise exposure problem. Author (GRA)

N86-20095# Institut Franco-Allemand de Recherches, St. Louis (France).
EXPERIMENTAL STUDY OF THE ACOUSTIC FIELDS FAR AND NEAR A MICROTURBO TRS 18 TURBOREACTOR [ETUDE EXPERIMENTALE DES CHAMPS ACOUSTIQUES PROCHES ET LOINTAINS D'UN TURBOREACTEUR MICROTURBO TRS 18]
C. JOHE and J. HAERTIG 26 Jun. 1984 42 p refs In FRENCH
(ISL-R-113/84) Avail: NTIS HC A03/MF A01

An experimental study was carried out to compare the acoustic field of a small turbojet with the field generated by a cold free jet excited or not. With subsonic jets the wide band noise shows a sinus variation associated to the turbine excitation. The azimuth field distribution is similar to that of the free jet. At maximum velocity the supercritical jet shows a far field similar to that of a nonexcited jet. The maximum emission is at a 30 deg angle, corresponding to the Oertel W Mach waves. Author (ESA)

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A86-25090
AIRCRAFT DESIGN AT KINGSTON POLYTECHNIC
R. WHITFORD (Kingston Polytechnic, Kingston-upon-Thames, England) Aircraft Engineering (ISSN 0002-2667), vol. 57, Dec. 1985, p. 10-12.

The aeronautical engineering group design project at Kingston Polytechnic is described. The role of the project supervisor and the establishment of design teams are discussed. The utilization of computer packages which will provide specific aircraft information to the students in tabular or graphical form is examined. The interaction between the team members and related industries is analyzed. The organization of the data by the project coordinator in order to produce the final design report is discussed. I.F.

N86-20165# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
RESEARCH AND DEVELOPMENT PROJECT SELECTION METHODS AT THE AIR FORCE WRIGHT AERONAUTICAL LABORATORIES M.S. Thesis
J. R. PRINCE Sep. 1985 77 p
(AD-A161153; AFIT/GSM/LSY/85S-29) Avail: NTIS HC A05/MF A01 CSCL 14B

This thesis sought to determine how in-house research projects are selected at the U.S. Air Force Wright Aeronautical Laboratories (AFWAL). The problem was explored by studying ten aspects of the research project selection process. This analysis was accomplished by using a combination of personal and telephone interviews. Ten individuals from each of the four AFWAL Laboratories were interviewed. The results illustrated that few of the respondents used a formal decision method model when selecting research projects. Most of the in-house projects selected at AFWAL are chosen via a consensus of agreement between the various levels of management in each laboratory. GRA

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SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

A86-22863#
ANALYSIS OF GAMMA RAY FAMILIES AND JETS UP TO 10 TO THE 7TH GEV OBTAINED DURING 1000 HOURS EXPOSURE OF EMULSION CHAMBERS ON THE CONCORDE
J.-N. CAPDEVIELLE (Bordeaux I, Universite, Gradignan, France) IN: High energy astrophysics; Proceedings of the Fourth Moriond Astrophysics Meeting, La Plagne, France, February 27-March 2, 1984 . Gif-sur-Yvette, France, Editions Frontieres, 1984, p. 129-138. refs

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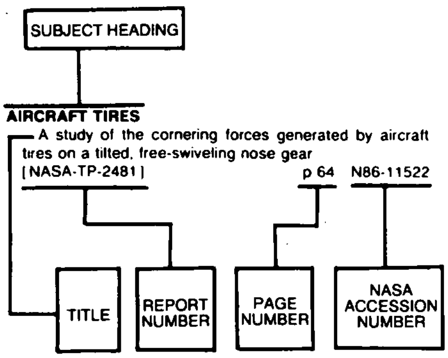

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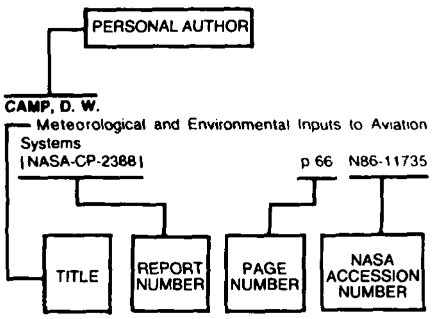

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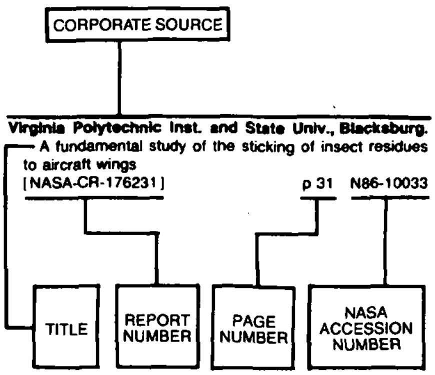

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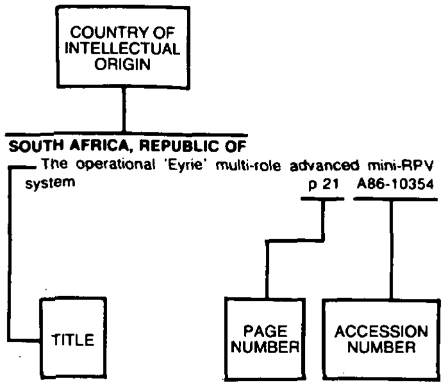

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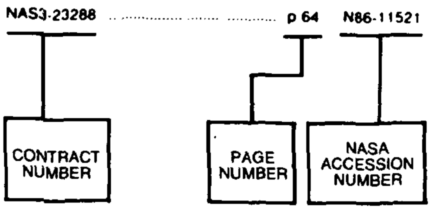

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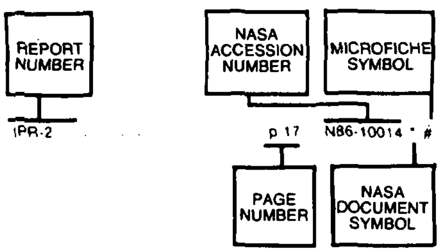

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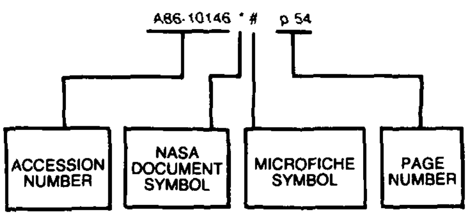

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